SCIENTIFIC AMERICAN SUPPLEMENT. No 1393

Scientific American, established 1845.
Scientific American Supplement. Vol. LIV. No. 1393.

NEW YORK, SEPTEMBER 13, 1902.

Scientific American Supplement. $5 a year.
Scientific American and Supplement. $7 a year.

[Continued from SUPPLEMENT, No. 1392, page 22308.]

THE KRUPP EXHIBIT AT THE DUESSELDORF EXPOSITION.

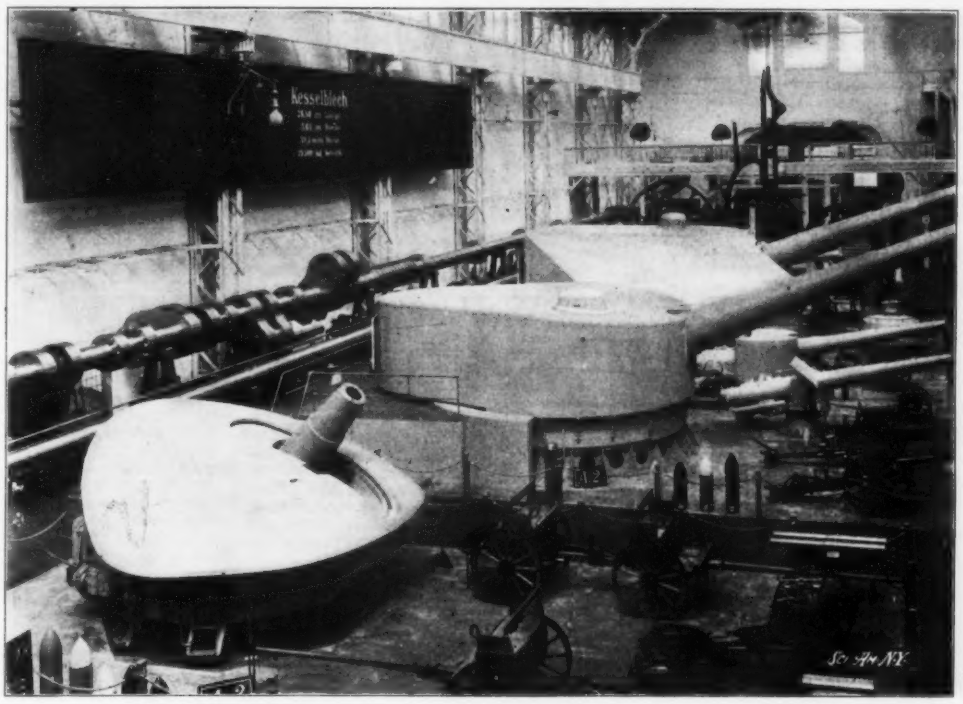
FIELD GUNS.

THE Krupp factory has exhibited one gun carriage with elastic spur and one carriage with recoiling gun of the model constructed 1901 as well as of the 1902 model, and further there is shown one field gun of this firm with recoiling gun and friction brake; that is to say, together, five field guns, which all have the same barrel of 7.5-centimeter bore and of 30-caliber length.

Four of the exhibited field guns are represented in Figs. 7-11. The various constructions shown can be explained in a few words. The essential difference between the carriage with elastic spur "C/1902" and the "C/1901" carriage consists in the longer cheeks of the former; therefore, the carriage angle is likewise correspondingly smaller, and the possibility of a rupture of the gun when the piece is discharged has thus been diminished. It must be admitted that the weight of the gun has been increased by 19 kilogrammes. But this is of little consequence as compared with the increased efficiency of the fire of this piece. In the latest construction the wheel brake can be applied only from the axle seat, and therefore it seems that the co-operation of the wheel brakes for checking the recoil has been dispensed with in this gun.

There are but insignificant differences between the constructions of the carriages with recoiling gun of 1901 and those of 1902. The illustrations show that in the latest construction the body of the carriage is curved, a change which has rendered it possible to place the beds for the gun axle in the cheeks of the carriage, while in the "C/1901" gun special axle beds are fixed on the carriage cheeks.

The "C/1901" carriage is provided with a rigid spur; carriage "C/1902" has a folding spur, connected with the carriage trail by means of joints so that it can be folded on the carriage. Therefore this gun can pass through trenches of a depth where the rigid spur of the "C/1901" model would catch into the ground.



28-cm. Howitzer with shield. — Two 30.5-cm. guns in turrets. — 19-cm. naval gun. 15-cm. coast defense gun.

21-cm. coast defense gun on disappearing mount. — 30.5-cm. gun in turret with inclined port plate. — 30.5-cm. gun in oval balanced turret with vertical port-plate. — Propeller shafting for "Kaiser Wilhelm II."

KRUPP EXHIBIT AT THE DUESSELDORF EXHIBITION.

Finally attention may be called to the fact that the "C/1901" carriage with recoiling gun is provided with axle seats, the three parts of which, consisting of back, seat and foot, can be extended into one straight shield which serves as a cover when the gun is discharged. As soon as the piece has to change its position these parts are replaced into the form of a seat by one angle manipulation. Carriage "C/1902," however, has only the ordinary axle seats.

The appearance of the two exhibited limbers for carriages with elastic spur and with recoiling gun is very much alike; they differ only in the manner in which the cartridges are packed. In the limbers for guns with elastic spur 40 cartridges are packed in steel boxes, each box containing four charges, while in the limbers for guns with recoiling barrel the cartridges are packed in eleven reed baskets with covers, four charges being inclosed each time in a wrapper of jute which can be easily removed.

Attention has already been called to the fact that besides these four field guns there is on exhibition one gun with recoiling barrel provided with a friction brake. The appearance of this gun does not differ from a gun with recoiling barrel fitted with hydraulic recoil cylinders. The only difference between both constructions is that the hydraulic cylinder has been replaced by a friction brake. The latter is usually constructed in such a manner that several flat rods attached to the gun are drawn along during the recoil, passing at the same time between a friction plate. The resistance of friction must vary according to whether the gun barrel recoils or advances, and therefore a mechanism has been arranged which causes the friction plates to press against the passing rods automatically and to a corresponding extent. The gun is run forward into the firing position in the usual manner, being acted upon by a spring.

Besides the above described guns, there is also exhibited one 10-centimeter howitzer having a carriage with elastic spur, as shown in Fig. 11. This carriage, with elastic spur, presents no new features to be described here. A long spring in connection with a spur which can be thrown out of action serves also in this case for checking the recoil and for running the gun forward into the firing position.

The 5-centimeter torpedo-boat gun (Fig. 12).—The gun which is supported by a center-pivot carriage stands on the dome of a torpedo-boat turret and can be turned around. The barrel rests in a cradle and is placed in a frame which turns on ball bearings in a pivot. This pivot is provided with a rack into which engages a worm turned by means of a hand-wheel. The thick-walled high-explosive shell of steel weighs 1.5 kilogrammes; it attained a maximum range of 4,950 meters, and, with a muzzle velocity of 700 meters, it can still pierce at a range of 1,000 meters a wrought iron plate of 79 millimeters thickness or a plate of hardened steel 51 millimeters thick.

Besides the above described guns, Krupp has also exhibited several other interesting collections included in the display of artillery material and consisting of:

1. A collection of breech mechanisms.

2. A collection of fixed ammunition cases and cartridge cases, including fabrics for cartridge bags, powder in the form of plates and of perforated bars.

3. A collection of projectiles and primers.

1. In the collection of breech closures we find among others:

(*a*) A screw closure with a trigger mechanism for recocking for guns of a small caliber (Fig. 13).

(*b*) A self-cocking screw closure for guns of medium and large caliber (Fig. 13).

These closures are based upon the use of a screw in which the threads are formed in series of steps. This screw has the advantage over the ordinary breech screw that in the latter the whole circumference consists of alternate plain and threaded parts, while in the former a larger circumference of the barrel is utilized for resisting the gas pressure when the piece is discharged. In the ordinary screw one-half of the circumference is used for receiving the rear thrust. However, in the screw in which the threads are formed in series of steps and which is used for the breeches of small calibers, there are, on the contrary, double rows of three threaded parts separated each time by a plain part; consequently the whole circumference of the screw is divided into eight parts, six of which representing three-fourths of the whole circumference, serve for receiving the recoil. The breech screw of the closure for guns of larger calibers is provided with double rows of five adjoining threaded parts, each of which is separated by a blank part. The circumference of this screw has thus been divided into twelve

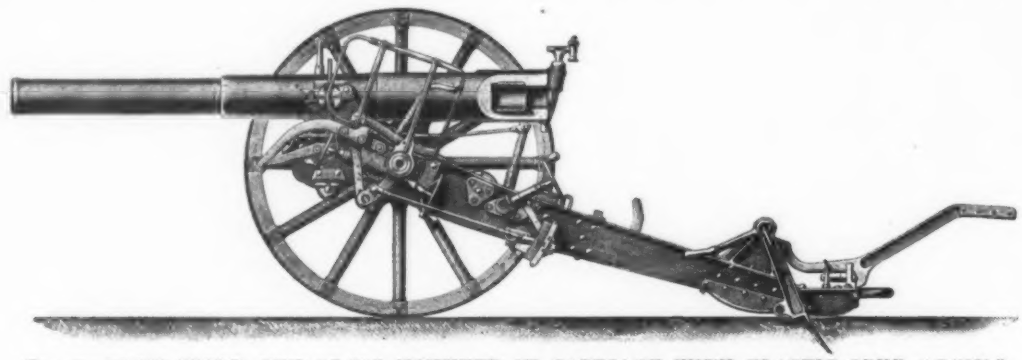


FIG. 7.—7.5-CM. FIELD GUN "L/30" MOUNTED IN CARRIAGE WITH ELASTIC SPUR "C/1901."

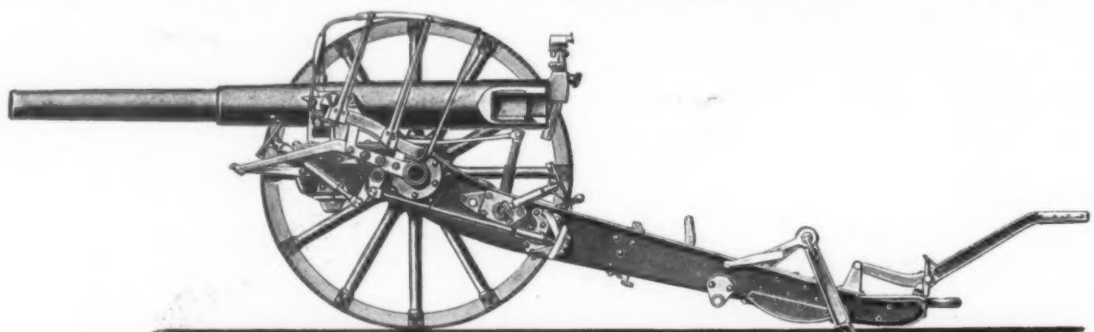


FIG. 8.—7.5-CM. FIELD GUN "L/30" MOUNTED IN CARRIAGE WITH ELASTIC SPUR "C/1902."

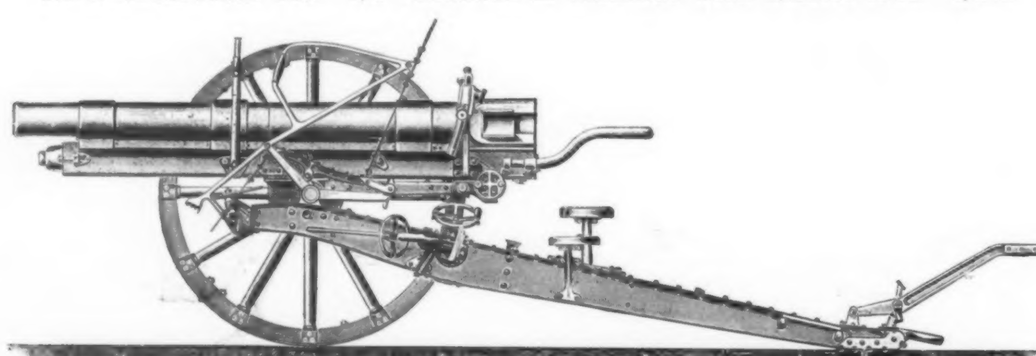


FIG. 9.—7.5-CM. FIELD GUN "L/30" MOUNTED IN CARRIAGE WITH RECOILING CYLINDER "C/1901."

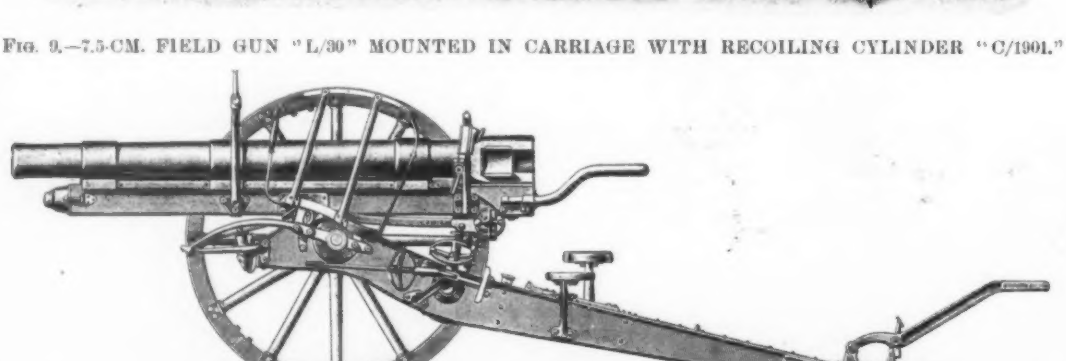


FIG. 10.—7.5-CM. FIELD GUN "L/30" MOUNTED IN CARRIAGE WITH RECOILING CYLINDER "C/1902."

parts, ten of which, representing ten-twelfths (that is, five-sixths) of the surface, transmit the recoil to the barrel. Attention may be called to the following technical innovation made in one of the exhibited small closures; the projections of the threaded parts are not separated from each other by sharp edges, they are rounded and pass into one another in the form of

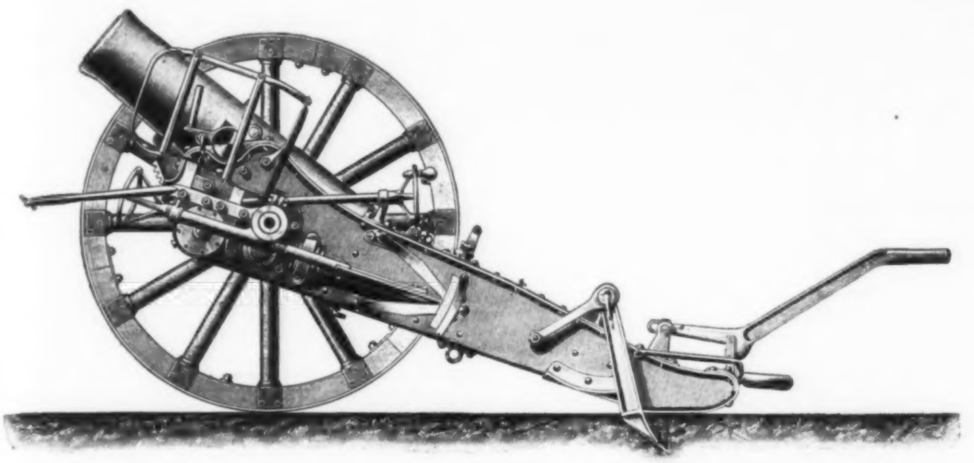


Fig. 11.—10-CM. FIELD HOWITZER "L/10" MOUNTED IN CARRIAGE WITH ELASTIC SPADE.

curves. Probably these curves can be more easily made; it seems, however, that without the sharp edges the number of those parts has been reduced which are easily liable to be injured.

The name "breech with recocking mechanism" has been substituted for the designation "repeating mechanism for discharging," which was formerly in use. It means that the cocking of the discharging mechanism is effected during the moment of firing; however, immediately after the piece has been discharged the firing lock returns automatically into the position of rest, allowing thus the discharging to be repeated without any necessity for the gunner who fires the gun to step near it. As in the screw closures for medium and large calibers, the breech mechanism in question is also provided with a safety device which prevents the premature opening of the breech and the accidental discharging of the gun. Either closure can be assembled and taken apart without the aid of any instrument. The firing pin and the firing pin spring can also be replaced when the breech is closed. Attention has already been called to the simple construction distinguishing the breech mechanisms.

However creditable this improvement of the screw fermeture may be, the fact remains that, so far, the principal defects of the system in question have not been overcome.

(c) The eccentric screw closure (Fig. 13) with trigger mechanism for recocking is constructed by Krupp according to the Nordenfelt system, being intended for guns of a small caliber (the exhibited field gun has a caliber of 7.5 centimeters). Attention may be called to the fact that the opening for loading provided in the breech block has no recess toward the edge. However, the interior arrangement of the breech has nothing in common with that of the Nordenfelt closure. This breech is likewise provided with a safety device which prevents the accidental firing of the gun and the premature opening of the breech.

Collection of Fixed Ammunition and Cartridge Cases.—There are exhibited altogether 40 fixed ammunition cases and cartridge cases of all the calibers in use, some of them in various lengths. Krupp uses for all rapid-fire guns metal cases which serve for receiving the charge and for closing the bore at the breech so tight that no gas can escape. Combination cartridge cases, where the projectile and the case are combined in a single cartridge, find application only in guns up to 15 centimeters caliber. In larger calibers, as well as in all howitzers and mortars, the projectiles and cartridges are divided. The cartridges for gu are firmly closed by metal covers, those for howitzers and mortars by a cover of pasteboard or brass which can be removed. The 30.5-centimeter and 28-centimeter cartridge cases are made of Durana metal, all others of brass. In another part of the exposition are exhibited three cartridge cases of nickel steel for 24-centimeter, as well as 28-centmeter cartridges, a special feature of which is the uniform thickness of the shell, as can be seen from the section made for this purpose. For field and mountain guns the Krupp factory also makes cartridge cases of an aluminium alloy, the weight of which amounts to one-third of what the brass cases weigh.

The charge is placed into the case either directly or in cartridge bags. The well-known defects of silk cloth (subsequent glowing) have caused the cartridges for howitzers to be made of powder in the form of sheets and for all other guns of powder in the form of texture. Powder in the form of sheets consists of smokeless powder rolled out to a paper-like mass, while powder in the form of texture is woven of filaments cut from sheet powder. Therefore powder burns in either form just like the charge and increases its propelling power. One cartridge is exhibited which has been filled with a charge in the form of powder disks placed one upon another like a plate buffing spring. This arrangement allows the case to be always filled up so that the charge reposes firmly in it without the application of some special medium. Another cartridge is filled with perforated powder in the form of bars, the length of which is equal to the height of the charge.

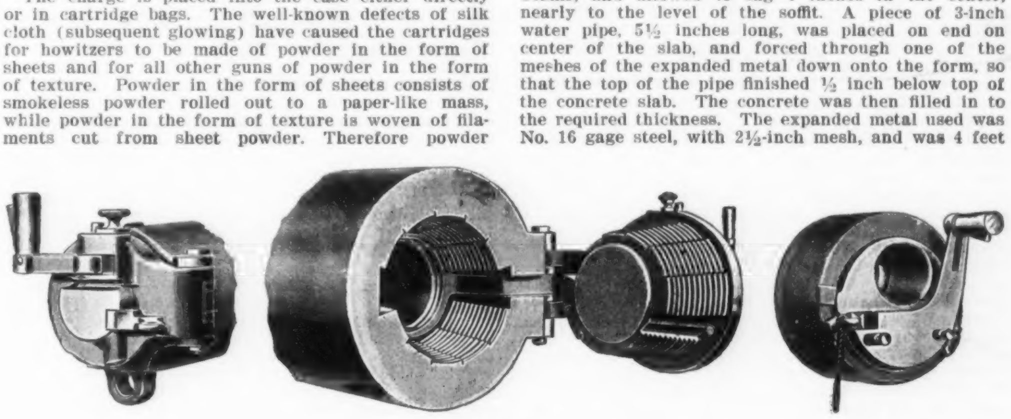


Fig. 13.

Screw closure for breech with trigger mechanism for recocking. Self-cocking screw closure. Eccentric screw closure with trigger mechanism for recocking.

Collection of Projectiles and Primers.—The exhibits of this collection are especially numerous; they comprise seventy-three propectiles of all calibers from 4.7 centimeters to 30.5 centimeters, and of each caliber those kinds and lengths are exhibited which are at present in use. The various kinds of projectiles are distinguished by respective coats of paint, i. e., thick walled explosive shells are painted white, steel shells gray-blue, explosive and mining shells yellow, shrapnels red, etc. Some shells are also fitted with a soft steel cap. These caps of soft steel serve to hold the point of the projectile together in piercing the hardened front side of the armor.

The collection of primers comprises twenty-eight pieces; two primers are exhibited of each kind, one of them being cut to show the inner parts. As all the twenty-eight differ from one another, our limited space prevents us from giving a detailed description of this instructive collection. Four of the ten percussion fuses are base primers and the remaining six top primers, one of each kind being provided with time-adjusting devices. The time fuse for 4-centimeter shrapnels burns only eight seconds; the seventeen double fuses burn from ten to forty-four seconds. Three double fuses have a fuse body of aluminium.

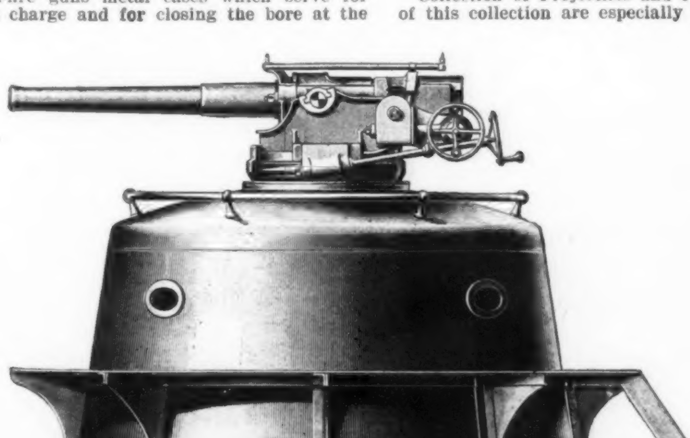


Fig. 12.—5-CM. GUN "L/40" MOUNTED IN TORPEDO-BOAT CARRIAGE.

CONCRETE SLAB TESTS.

An interesting test of a concrete slab reinforced with expanded metal is recorded by the assistant engineer, Baltimore (O. W. Connet). The test was made in connection with plans to replace wooden floors on some bridges in that city. The slab was 6 inches in thickness, reinforced with the metal. The account reported in the Engineering Record is briefly as follows: Two iron I-beams 15 inches deep and 6 feet long were placed on stout wooden trestles about 8 feet above the ground; these beams were rigidly kept apart (3 feet to centers) by two 2-inch by 12-inch by 35-inch planks 4 feet apart, and by two ¾-inch bolts placed inside each plank to hold the iron beams tightly together at the distance. A form or center was made of inch plank for the concrete, which gave for a width of 21½ inches a thickness of 6 inches as a soffit below the upper surface of concrete floor, and this was shaped slantwise to the lower flanges, forming an inverted trough shape. The upper surface of concrete was 1½ inches thick above top flanges. "The concrete on this center was thoroughly rammed in between it and the I-beams and brought up to the proper position of the expanded metal, which was then laid across the top of beams, and allowed to sag 4 inches in the center, nearly to the level of the soffit. A piece of 3-inch water pipe, 5½ inches long, was placed on end on center of the slab, and forced through one of the meshes of the expanded metal down onto the form, so that the top of the pipe finished ½ inch below top of the concrete slab. The concrete was then filled in to the required thickness. The expanded metal used was No. 16 gage steel, with 2½-inch mesh, and was 4 feet long across the beams by 3 feet in the other direction. The concrete was composed of one part of American Portland cement (Nazareth), two parts clean fine river sand and four parts of crushed gneiss stone of a size to pass through a 1½-inch ring down to ¼-inch stone." The form or center was removed after the concrete had set for seven days, and on the twenty-eighth day the test was made. "A washer of Georgia pine, 12 inches square, 3 inches thick, was laid directly over the hole in the center of the scale, and an iron washer 4 inches in diameter was placed on top of the wood one; a 2-inch bolt, with a hook on the lower end, was put through there and held up by a nut. Four strands of ⅞-inch wire cable were suspended from the hook and passed round six iron gutter plates 5 feet by 6 feet 8 inches, ¾ inch thick. On these plates timbers and planks were laid, on which street paving blocks were piled until the bolt pulled a hole through the concrete. After about 20 tons had been put on them small cracks began to show on the under side of slab, radiating from center in practically straight lines toward the corners of the slab. These cracks did not perceptibly increase as the load was increased, and there was no deflection of the top of slab before it failed. When it failed the bolt pulled through, carrying with it a conical-shaped mass of concrete and tearing the expanded metal apart. The hole in the top of the slab was elliptical in shape, 8 inches by 11 inches, while below the slab it was more nearly square, about 20 inches at the sides. The total concentrated load on the bolt at the time of failure was 28 tons." Such is the description given of a test that would be much in excess of any test that could ever take place on a bridge, as the pavement would distribute the load more than the washers. In fact in this test the iron washer crushed into the wood over an inch, and the iron pipe through the slab helped to weaken it. The writer says: "As loads of 5 tons on one wheel are rare, this test would give a factor of safety of between five and six. The test is useful as showing what a slab of concrete reinforced by expanded metal, which acts in this case to resist the tensile stress near the bottom of slab, will stand, although we would remark in practice a 6-inch slab shaped like this, barely 3 feet between the beams, would be thought rather deep. The form given by the center of trough-like section adds much, no doubt, to the strength of the concrete slab. Underneath the appearance of such a floor would be a series of longitudinal grooves or panels, and would be an improvement on a simple horizontal slab of concrete resting on the beams, or one solid flat soffit. This construction has at least the merit of simplicity, which many of the patented systems of fireproof construction have not."

PINE-NEEDLE OIL IN GERMANY.

The Thuringen Mountains of southern Germany are the home of the makers of pine-needle oil, extract, and similar products, which are used the world over for rheumatic and kindred complaints.

For the manufacture of these articles on a small scale, an ordinary pharmaceutical distilling apparatus can be used; but for a large industry, specially designed apparatus must be employed. Franz Hering, of Jena, makes these up to a capacity of 3,000 liters (2,724 quarts) of pine needles.

The needles and very young shoots of the various kinds of pine trees, more particularly those of the *Pinus pumilio*, are used for the manufacture of these

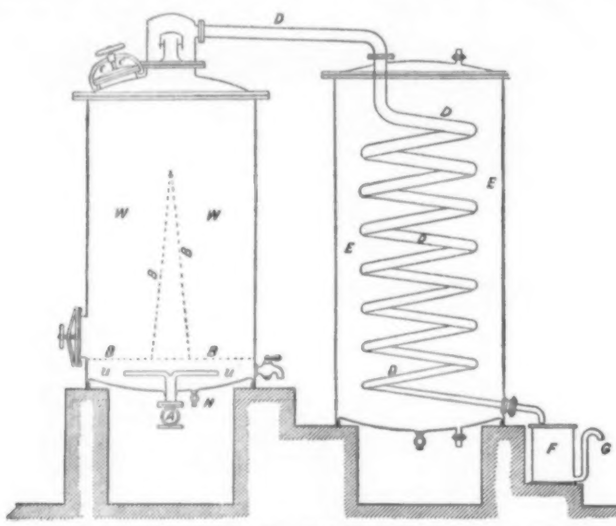


Fig. 1.—LARGE-SIZED DISTILLING APPARATUS.

products. They are collected in the latter part of May or the first of June and are cut up into small pieces and put into the cylinder of the distillation apparatus, through opening, *C* (see Fig. 1). At *A* steam enters the base of the cylinder and is conducted underneath the bottom, *B*, which is usually made of zinc and is perforated, the central part rising in the shape of a cone or funnel. Through the perforations, the steam finds its way to the needles heaped up in the cylinder and the volatile oils contained therein are freed and make their exit, together with the steam, by means of a pipe, *D*, which connects with the cooling cylinder, *E*. Cold water runs continually from the top into this cylinder, playing around the so-called "serpent pipe," *D*, and cooling its contents and then finding an exit at the bottom. Thus, the contents of pipe, *D*, become condensed and the liquid runs into the bottle, *F*, at at the base of the cooling cylinder, where the oil is found swimming on the surface. The oil must from time to time be skimmed off, while the water runs out at pipe, *G*. As this water is not entirely free from the oils, it is advisable to have it subjected to a rectifying process in order to save the oil, which would otherwise be wasted; or the separation can be effected by the application of salts.

PINE-NEEDLE EXTRACT FOR MEDICATING BATHS.

When the steam has extracted the oils from the mass in the distilling cylinder, the condensed water (containing resinous, albuminous, and tannated substances) drops through the perforations, *B*, and collects in space, *u*, below; thence it is drawn off by means of tap, *H*, and taken by a pipe to the vacuum apparatus shown in Fig. 2, which represents the outside of the apparatus, while the dotted line, *T*, shows the lower part of the boiler on the inside. The boiler is half filled with the condensed water, which, by means of steam entering through pipe, *N*, and passing underneath the boiler to find its exit at *J* into pipe, *M*, is heated and caused to evaporate. This process is greatly aided by the fact that the space, *S*, above it is void of air, this having been drawn out by means of a pump, connected with the apparatus by pipe, *O*. The evaporating process is continued until the contents have reached the desired consistency. The extract is then drawn off, mixed with pine-needle oil in order to give it the necessary perfume, and put up in jars.

PINE-NEEDLE FIBER.

The mass left in the cylinder, *W*, after both the above-described processes are finished, is dried and put into a machine to separate and loosen the several fibers. These are then perfumed with pine-needle oil, put up in assorted packages, and sent to the different markets, where they are sold for pillow and mattress stuffing. The fiber is considered very healthy and vermin-proof.

THERMO-ELECTRIC MEASUREMENT OF STRESS.

An elaborate paper on this subject, by C. A. P. Turner, M. Am. Soc. C.E., appears in a recent number of the Transactions of the American Society of C.E. Mr. Turner fully describes the methods used, and the results obtained, as they apply to fiber stress in columns, and impact and vibration under rolling loads. In the measurement of stress by thermo-electric means two different methods may be used. (A) By measuring the temperature change in bar when load is applied or removed, "but this method is applicable only while the load is being applied or removed, and cannot be used at any time after, as the thermal change in the bar is gradually dissipated by radiation." (B) By measurements indicating the extent of the temporary change in the thermo-electric intensity of the bar, due to the stress applied. This change subsists as long as the constraining force is kept applied, and hence the method is applicable to the measurements of either live or dead-load stresses." The author has adopted the first method, and the measurements by it have been reduced to a scientific basis. The law upon which thermal measurement of stress depends is stated as follows: "Any substance which expands upon being heated absorbs heat (i. e., grows cooler) upon being stretched, and vice versa." The author applies Lord Kelvin's formula, a formula rigidly exact for any solid, only for an infinitesimal increment in the pressure applied. But the subject is too elaborate to be dealt with in this notice. Those interested in the question will find Mr. Turner's paper a valuable contribution. One of the most interesting applications is the compound stress (tension in one direction and compression in another) found in a plate girder with stiffened web. The author gives two diagrams showing his conclusions from a thermo-electric investigation of the internal stress. The author says the usual text book analysis of the internal stress in a wall-plate is radically wrong. "The distribution of the stress through the wall-plate is in belts, and the position of these belts varies with the position of the stiffening angles." It is shown that a plate girder can be excessively stiffened by the stiffeners being placed needlessly close together, and those girders when they are spaced economically, i. e., sufficiently close to prevent buckling of the web, etc., to develop strength of flange. The question opens up a large field of inquiry in construction, and the thermo-electric measurement of stress will be useful in proving and correcting modes of construction. The experiments recorded in tabular form on bars, and the descriptions of testing apparatus, galvanometers, Olsen's testing machine, are instructive.

THE PERSEID METEORIC SHOWER OF 1902.

The display of Perseid meteors was fairly abundant this year, though somewhat marred, and only partially observed, in consequence of the unsettled weather which prevailed. In the west of England the first half of August proved an exceptionally cloudy period, and comparatively few observations could be secured. In the eastern counties atmospheric conditions appear to have been decidedly more favorable, for while at Bristol only meager results could be gathered from skies wholly or partially veiled with clouds, observers in metropolitan suburbs reported clear weather and collected a plentiful harvest of meteor flights. At Hampstead Mr. G. M. Knight counted 500 meteors during the first fortnight of August. Between August 1 and 5 167 were recorded, and on August 10 from 11h. 30m. to 15h. 15m., 239 were seen. The majority of them were Perseids of the usual swift, streak-leaving type, and there were minor showers in Cassiopeia, Andromeda, Cepheus and other regions. Mr. Knight has forwarded the writer some charts containing projections of his recorded paths, and the place of the Perseid raidant appeared to be indicated as under. The ephemeris positions given in the Monthly Notices, December, 1901, p. 169, are also added for comparison:

1902.	Radiant.	No. of meteors.	Ephemeris.
August 1-3	37° + 55°	12	33.9° + 55.0°
August 4-5	40° + 55½°	26	37.0° + 55.6°
August 10	44½° + 57°	43	44.3° + 56.9°

The agreement is fairly good, though the places observed this year in the early part of August are somewhat east of the predicted centers. A certain allowance has, however, to be made for errors of observation.

At Bristol the writer watched for the Perseids on parts of the nights of August 2, 6, 10, 12 and 14, but clouds prevented anything like a thorough investigation of the progress of the display. The Perseids were fairly numerous, and shot from the radiants given below, but very few meteors were seen on August 6 and 14 owing to the clouds, so that the points of emanation on those nights were merely suspected:

1902.	Radiant.	Ephemeris.
August 6	39° + 57°	38.9° + 56.0°
August 10	45° + 58½°	44.3° + 56.9°
August 12	47° + 58½°	47.1° + 57.3°
August 14	50° + 57°	50.0° + 57.7°

The year 1900 not having been a leap year, the maximum was expected on either August 11 or 12. There was an unusually bright exhibition of these meteors on August 11, 1898. It seems that the maximum intensity was well defined this year, for "a magnificent shower of Perseids" is reported to have been witnessed at Odessa on Tuesday night, August 12. The chief radiating point is said to have been at an altitude of 45 or 50 deg. in the northeast firmament. The latter position corresponds approximately with the normal place of the Perseid center. But, unfortunately, the report mentions no details as to the number of meteors observed or the duration of the observations, and it is impossible, therefore, to form any exact conclusion as to the character of the display witnessed. It will probably be found, however, when particulars come to hand, that it represented nothing more than a tolerably plentiful return of the stream. There are no other descriptions favoring the inference that a strikingly brilliant shower was witnessed. In and since 1898 the Perseids appear to have been richer than usual, though it is extremely difficult to ascertain the relative strength of the shower from year to year owing to the variable conditions affecting the visibility of the meteors.—By W. F. Denning, in Nature.

Foreign Physicians in Peru.—Under date of July 18, 1902, Consul Charles V. Herdliska, of Callao, in reply to an inquiry regarding the chances of success for an American physician in Lima, writes as follows:

Before a physician can enter upon the practice of his profession in Peru, he must pass a State examination upon medicine, conducted in the Spanish language. Upon being found qualified, a certificate is issued which entitles him to practise his profession in any part of the Republic. The opportunities for American physicians would seem to be good. Both Lima and Callao contain quite a large American and English colony and the Peruvians themselves appear to have great faith in the American, English, German and French physicians and surgeons on account of the advanced state of medical science in those countries.

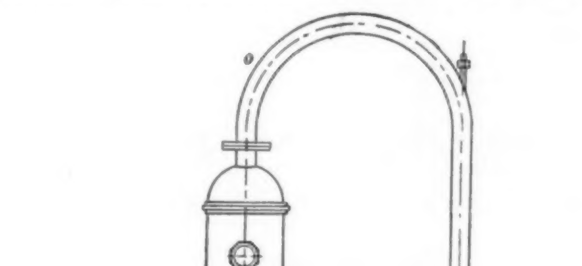


Fig. 2.—VACUUM APPARATUS.

GAS ENGINE IGNITION BY CONTACT OR CATALYTIC ACTION.

For nearly eight years experiments have been made to utilize the catalytic properties of platinum for ignition in explosive motors. That is to say, it was sought to make use in the ignition of motors of the well-known phenomenon that a coil of platinum wire which has been raised to a red heat remains at this temperature when suspended over a reservoir containing alcohol, benzol, ether, etc. The vapors of these hydrocarbons mixed with air when coming in contact with the metal are absorbed, or perhaps it would be better to say condensed in the pores of the metal, and the heat generated by this condensation maintains the spiral in a state of incandescence. These vapors have only the property of maintaining the platinum incandescent, but cannot produce the initial heating. Hydrogen only is capable of effecting this under certain conditions.

The phenomenon of catalytic action was first observed by Dobereiner. In 1829 Johann Wolfgang Dobereiner (1780-1849), professor of chemistry at the University of Jena, Germany, published a work entitled "On Some Remarkable Properties of Platinum, Recently Discovered."

He applied his discovery to a device bearing his name, consisting of a small hydrogen generator, which carried, near the exit of the gas, a little spongy platinum. As soon as this spongy platinum comes in contact with the gas it becomes incandescent and ignites the gas without being changed in any manner. An attempt was made to explain this action by assuming that bodies which produced it had hidden in them a peculiar power called catalytic power.

But, as it was well stated by Regnault, professor of physics at the Collège de France in 1841, this was to substitute a word for a fact and to remain satisfied with that. Even to-day this phenomenon is little understood. Later on this property of platinum and other materials to effect a reaction of various substances without taking a part in the reaction was given the names contact effect, action of presence, occlusion, catalytic action, etc. Thus, for instance, finely divided silver placed in oxygenized water effects a decomposition of that liquid without being modified thereby. This property of platinum, silver and wood charcoal to chemically combine a mixture of oxygen and hydrogen seems to result from the property of these bodies to absorb these gases in their pores, thereby bringing the molecules in closer contact and thus facilitating the reaction. No great success has yet been attained in applying this property to explosion motor ignition.

In fact, to make this system of ignition practical and automatic, the metal which produces the catalytic action must be placed in proximity to the explosive chamber, where the explosive mixture is brought in contact with it by the compression. The causes of failure have been of various kinds. Sometimes the platinum would fuse, and when fused into a small bead the contact surface it presented was insufficient to produce ignition. Again, the temperature attained by the platinum was insufficient, owing to an ill-proportioned mixture. In fact, a mixture which gives the strongest explosion is too poor in hydrogen for the platinum to reach the required temperature unless the compression is at the same time high. Only a short time ago the compression of motors was still quite low—forty-five pounds per square inch—and this did not suffice to make up for the lack of hydrogen.

On the other hand, in motors with hit and miss governor the platinum would cool during the idle revolutions to such an extent as to fail to ignite the next charge admitted. The same trouble was experienced with slow-speed motors.

The other metals of the platinum group—rhodium, iridium, palladium, ruthenium and osmium—had not yet been experimented with for this purpose.

At the beginning of 1895 I undertook some experiments on the application of this principle to motor ignition. I designed an ignition apparatus on which patents were granted in France, October 10, 1895, and March 25, 1896, in which the metal was placed in the cylinder itself. Platinum did not give satisfactory results—it almost invariably fused. Then I tried a platinum alloy, which still fused occasionally when the compression became too high, but gave finally quite good results. Later on, to make use of the gaseous mixture of best proportion, I inclosed a small, very thin walled tube of platinum-iridium in another tube closed at one end. The latter was heated by radiation. Into the small tube, which had a large radiating surface compared to its mass, the gaseous mixture was injected under pressure, by means of a pump, and a special carbureter prepared the most effective mixture.

This apparatus was rather voluminous, but operated well. I never noticed a misfire of my motor. My motor bicycle race, Saint Germaine-Ecquevilly, on June 20, 1897, was fitted with this ignition apparatus.

On March 18, 1899, I patented a combination of this apparatus, with an electric igniter. In this system electric sparks are used for ignition to start the motor. The heat of the first explosions raises the platinum to incandescence. At this moment the current is interrupted and the pump operated by the motor directly furnishes the gas to maintain the catalytic action.

The system comprised a small tube, fixed to the motor, the dimensions of which determined the time of ignition. The time of ignition was controlled manually by means of the admission.

This device I have had in use on one of my vehicles for four years without ever having had cause to complain about it, and the power of the motor was increased by it.

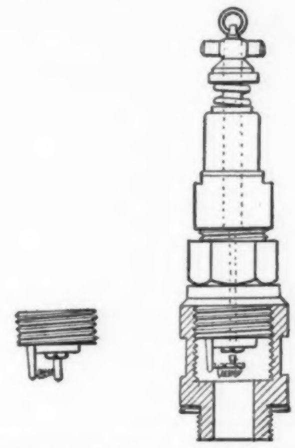
In experimenting with the other metals named above I observed:

1. The objection to using palladium is that it fuses at too low a temperature.

2. The objection to using osmium and ruthenium is their easy volatilization above about 1,600 deg. C. and the poisonous character of the osmic and ruthenic acids formed by them.

Rhodium melts at about 2,000 deg. C., and of all the metals I have experimented with it possesses the most pronounced catalytic properties with the explosive mixture used in motors. The problem was to devise means to use this slightly malleable metal. This object has been attained by alloying it in certain proportions with platinum-iridium. This alloy has a considerable malleability and can be rolled and drawn into fine wire. It then possesses remarkable catalytic properties, being at the same time little affected by the high temperature produced by the catalytic action. It may advantageously be placed close to the cylinder, where the charge is brought in contact with it, thus obtaining an automatic ignition, which remains in operation as long as the motor runs, and requires no auxiliary source of gas for the igniter.

The device, which is patented in France and foreign



TWO FORMS OF THE GANS DE FABRICE ELECTRO-CATALYTIC SPARKING PLUG.

countries, is extremely simple, as seen from the accompanying drawing of it. To the upper part of an ignition plug of the usual type is attached a helical coil of fine wire of this rhodium-platinum-iridium alloy, preferably between the two terminals. To adjust the time of ignition the threaded part of the plug is provided with a small chamber, the space of which can be varied in accordance with the compression of the motor on which it is to be used.

To start the motor an electrical current may be sent through the wire to heat it. Once hot the wire is further raised in temperature by the catalytic action, in proportion to the speed of the motor.

The time of ignition is advanced by controlling the admission of gas. A greater or smaller quantity of the explosive mixture causes the ignition to occur at a more or less advanced period, since the compression brings the gas in contact with the spiral more or less quickly.

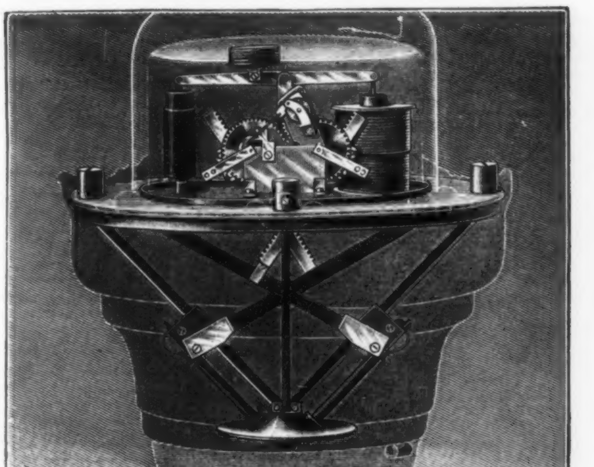
But instead of fastening the wire between the two terminals it may also be fastened in place as follows:

Leaving the ordinary ignition plug as it is, the helice of wire is fixed in the explosion chamber near one of the terminals of the plug. The motor is then started by means of an electric spark between the two terminals; the circuit is broken as soon as the helice has become hot, which requires less than a minute.—Dr. Paul Gans de Fabrice, in La Locomotion.

A NEW ARC LAMP.

We illustrate herewith, from La Nature, the "Hackl" electric lamp manufactured by the Ganz establishment of Budapest, and which is designed to be operated by an alternating current of 10 amperes at a tension of from 28 to 30 volts. In order to obtain an effective distribution of the light, especially beneath the carbons, the latter are inclined toward each other at an angle of about 90 deg., so that the greater part of the rays that emanate therefrom are projected downward, while those that are directed upward are sent back by a reflector arranged just above the arc. The lighting effected by an apparatus of this kind is of the most satisfactory character and much superior to that of ordinary lamps, and the more so in that much less light is lost in the region above. According to data furnished by the manufacturers, the consumption of a Hackl lamp is but 0.52 watt, while the corresponding consumption of an ordinary globe lamp is 1.56 watt per normal candle.

The mechanism is very simple, and comprises but two racks, one for each carbon. These racks are accompanied with a series of pinions and a lever device for assuring a regular motion of the carbons. The entire mechanism is actuated by the weight of the carbons and carbon holders, and the motion is controlled by a solenoid. The lamp requires but from 28 to 30 volts, and, with a tension of from 100 to 105 volts, permits of placing three lamps in series. It takes up but little space, and makes no noise, and the simplicity of the mechanism prevents any irregularity that might result from the imperfect operation of the chains. We shall not dwell upon the arrangement of the mechanism, which may be understood from an inspection of the figure, but shall simply state in conclusion that the lamp is not to be recommended for continuous currents.



THE HACKL ARC LAMP.

THE MANUFACTURE OF BISULPHIDE OF CARBON IN THE ELECTRIC FURNACE.*

By Edward R. Taylor.

Having been engaged in the manufacture of the bisulphide of carbon for about twenty-five years, and quite familiar with the disagreeableness of former methods, more than twenty years ago the author turned his thought to a possible electric method as the most feasible means of placing the production upon a better basis. Because of these disagreeable features, at least, six different parties in the country have in that time given up its manufacture in disgust, and the author should have done so himself, but was unable to let go and, therefore, set upon himself the development of a better process, which has been the careful study of years.

In any process of heat derived from combustion, the carbon and sulphur, which are the reacting materials, must be separated from the combustion chamber, or the very material required would be oxidized to other products. This separation was effected in retorts of fire-clay or iron, heated externally, with suitable provision for the removal and condensation of the product. Clay retorts are more enduring than iron, but have to be thicker, and, being poorer conductors of heat, have their disadvantages to offset their longer endurance. With either of them a very small fraction only of the heat developed by combustion becomes effective in combining the carbon and sulphur which, as is well known, is a process requiring the addition of heat to effect.

Moreover, these retorts must be limited in size to be effective at all in the accomplishment of the work, and the building in which they are placed becomes like an oven with an atmosphere anything but agreeable to be in.

To overcome these many disagreeable features, as well as to apply the heat inside where it is required to do the work, I gave early thought to the development of an electrical process. This has proved in practice to be as practical, cleanly and desirable as my fondest hopes ever pictured.

The first furnace for this purpose was surrounded with an external shell of iron in which the sulphur was melted by heat radiated from the inner metal shell of the furnace, and admitted to the furnace proper in the melted state by means of valves. This practice was found to be inconvenient and unsatisfactory, and arrangements were made to substitute brick walls for those of metal, and to feed the sulphur directly to the furnace in the cold state, surrounding the interior so completely as practically to make a blanket of sulphur which in melting carries the heat absorbed back into the furnace. So effective is this regeneration that the larger the production of goods the cooler is the outside of the furnace, and the more effective the utilization of the heat generated in the interior in the production of bisulphide.

In the building containing the furnace, there are

* A paper read at the Inaugural Meeting of the American Electrochemical Society, Philadelphia, April 4, 1902, President Richards in the Chair.

no unpleasant gases or other features that are in the least disagreeable, and the whole building is at all times comfortable to be in in every respect. If necessary other operations could be conducted therein with entire satisfaction.

The life of the electrodes received my early consideration, and arrangements were made to keep them constantly and automatically supplied with broken carbons, which provide the electrodes with a large contact surface, against which they lie and from which the broken carbons taper off to the interior of the furnace, where the greater resistance converts the electrical energy into heat just where it is required for effective work. All of this is made clear by the drawings.

The sulphur rises in the bottom of the furnace and its height is regulated by feeding cold sulphur into the surrounding chambers according to requirements, and being a non-conductor of electricity becomes an important factor in regulating the current passing through the furnace.

The induction type Stanley generators, of 330 kilowatt capacity each, furnish the electricity without the intervention of transformers, the current being easily regulated by the field and exciter rheostats.

With regular supplies of electricity and materials required in the furnace nothing can exceed the ease and satisfaction of its operation, which is continuous for many months together.

NOTE.—We understand that as much as 10,000 pounds of bi-sulphide of carbon has been produced in one of these furnaces in twenty-four hours.

In later patents provision has been made for fusing the residue from the carbon and the sulphur and removing the same as a fused slag, and it is anticipated that with this accomplished a much longer continuous run might be made in one furnace.

Provision is also made for the complete renewal of the electrodes by feeding broken conductive material through suitable conduits offering a large contact surface for such fragments, thus securing the stationary part of the electrodes against excessive heat in the passage of the electricity from one to the other.

This arrangement makes possible the construction and operation of an electric furnace that can be continuously run for very long periods of time with the utmost regularity and without the interruptions incident to movable electrodes, the renewal being more uniformly accomplished by the regular descent of the broken conductive material.

Provision is also made for changing the direction of the electricity through the furnace, by means of which the formation of piers which might hold up the descending charge may be prevented, or, if formed, may be removed, thus insuring the regular descent of the charge and the continuity of the operation.

LONG DISTANCE POWER TRANSMISSION.*

By F. A. C. PERRINE.

Two elements make success in the long distance electrical transmission of power—continuity and regulation. Perhaps these are the most important elements in any electrical undertaking and are the most obvious, but in attaining our ideal in long distance work there lurk pitfalls about these two elements unknown in other fields of the art. From the outset, in the original studies and down the line to the last switch and insulation, lie unknown problems and problems known but unsolved. It is the field of the thoughtful, independent engineer; the ground is stony and fit traveling only to the most resourceful.

THE REGULATION.

Regulation in direct current work is a simple problem. Its laws are all known; at every lamp it is quite easy to predict the variation of voltage. The same laws control whether the lines be long or short. In his transmission plants Thury has met no new difficulties but has effected regulation at 10 or 20 miles, just as he would have done had the delivery been made only in the next room to his dynamos. Resistance is always resistance and his dynamo characteristics remain unaltered by its increase. He deals only with current, voltage and resistance and encounters problems simple even to Faraday, Henry or Ohm.

It has been said very truly that the introduction of the alternating current raised the electrician above the rank of the artisan. With these currents he is no longer dealing with a few simple, independent quantities connected by a primary rule, but must now consider many new elements, some constants and some variables. At every step capacities and self inductions enter into the solution in complex and involved relations. Regulation can no longer be simply determined for each part of the system independently, and the regulation of the whole obtained by a consideration of the parts separately. Self inductions and capacities affect each other, and the generators and lines, as well as the transformers and motors must be chosen or designed with this interdependent relation in view. A simple case illustrates this beautifully.

When the operation of the transmission supplying current to the city of Stockton, Cal., from the power plant at Mokelumne Hill, forty-six miles away, was first begun a curious state of affairs was observed. In operation of the lines alone the current required on the 2,200-volt side of the step-up transformers was 60 amperes; with the step-down transformers connected the current fell to about 50 amperes, and when a 100-kilowatt motor was put into operation the current was only 55 amperes. The transmission was designed to be at 25,000 volts, but at the delivery end of the line the voltage was found to be 27,200 volts, and finally the motors consumed full current when running at no load and not much more when operating with full load applied. I think that all will agree that here are problems enough for one small instance of the difficulties in the regulation of a long distance transmission plant. The lines in this case had been calculated for an 8 per cent loss of energy for transmission of 1,000 kilowatts, and capacity played the most important part in these pranks of voltage and current.

With the lines alone the capacity was so great as to absorb an apparent energy of over 130 kilo-volt amperes. This is reduced when the transformers are connected and some real energy begins to flow and the self induction of the step-down transformers neutralizes some of the capacity of the line. When the motors are connected the real energy is increased and the self inductances of the various parts of the system become more important. The apparent rise of voltage along the line illustrates the interdependence of the whole system even more clearly, for it is only in a very small part due to the line itself, or rather, while due to the line, it occurs in the step-up transformers and not to any extent along the line.

It is not uncommon to attribute such an effect to resonance, which really only rarely becomes important; in reality, the regulation of the transformer produces this effect. With any transformer fed with a constant voltage at the primary the secondary voltage falls with non-inductive load and falls still further if an inductive load is applied, but if the load is a capacity load the secondary voltage rises instead of falls. In this case, therefore, the step-up transformers were delivering a 10 per cent higher voltage to the line than their transformation ratio accounted for, which necessarily disturbed the regulation seriously. This trouble became even more serious when a heavy induction motor was later operated by the same plant. The load on the motor accounted for a fall of potential amounting to 4 per cent, but the inductance produced a drop of 10 per cent at least; and, as the rise of voltage on the line at no load was as much as 10 per cent, it may at once be seen that the voltage varied when the motor was connected from 10 per cent above normal to 10 per cent below, and thus a variation exceeding 20 per cent was produced in place of a variation of 4 per cent, for which the load allowed.

The effect upon the synchronous motor was also due to this ever-troublesome capacity. The generators were giving nearly a true sine wave of E. M. F., while the motors were designed for a peaked wave, the line capacity so affected the generator wave that the difference between the motor and generator became great, and for part of each wave the motor was absorbing power, and for its remainder delivering power, so that always a great current was flowing.

In this particular case these troubles were corrected by the introduction of a heavy self induction across the ends of the line which neutralized the line capacity; and this self induction was used until an inductive load was connected in the shape of induction motors, which rendered the use of an extra self induction unnecessary. Whenever this arrangement can be thoroughly carried out and the capacities and self inductions connected to any line be evenly balanced the alternating problem can be reduced to the simplicity of the direct current problem and long algebraic equation abandoned in determination of the expectations. This possibility is beginning to be appreciated and regulation attained in long distance transmissions which could not otherwise be hoped for.

There is little service which calls for absolutely continuous power. Most plants, which are said to be operating "day and night," shut down at meal times and are rarely operated more than twenty hours of the twenty-four, and even where the operation is continuous through the day there is a cessation of operation on Sundays and holidays. For this reason it is difficult to satisfactorily balance the capacity of the line against the inductance of any load. The line capacity current is constant and is continuously in evidence so long as the voltage is applied to the line; indeed, it varies only with the voltage and periodicity. Its importance increases as the load diminishes, for when the load is heavy it is not only completely overcome by inductance, but also is rendered unimportant by reason of the presence of a large current in phase with the electromotive force. During the time when all loads are diminished the disturbance of regulation by reason of the presence of a line capacity current is most apparent, and consequently the counteraction of that capacity effect, by a heavily inductive load which is off during these same periods, is a remedy which only accentuates the disease. This was illustrated in the case described above where a severe induction load depressed the voltage and its removal allowed the full rise due to line capacity.

In the case of the Standard Electric Company's transmission and that of the Bay Counties Power Company, where transmissions of approximately 150 miles at 50,000 volts and 60 cycles are undertaken, the charging current is approximately 40 amperes; or, in other words, the line requires the full capacity of a 2,000-kilowatt machine for charging it as a condenser. The complete neutralization of this great capacity effect would require the continuous working of something in excess of 5,000 kilowatts of induction motors with average normal power factors. Up to the present time no load on the Bay Counties lines has ever been applied which is capable of neutralizing this capacity effect. The power house is practically unable to have much knowledge of the loads actually applied on the lines except by observing the wattmeters or the wheel nozzles, since the current from no load up to a load of several thousand kilowatts remains practically constant. As there are many branching lines supplied from this system it is impossible to operate other than with constant E. M. F. at the dynamos, and the regulation of the long lines is affected by the capacity, which influences everything from the step-up transformers to the last motor. In order to overcome the troubles due to this source the Bay Counties Company have arranged to place upon their lines impedance coils capable of practically neutralizing the entire capacity of their long lines; and, as soon as these are installed, one of their greatest difficulties in obtaining satisfactory regulation will be removed. With the capacity of the line neutralized it then becomes necessary to keep the load as nearly noninductive as possible by continuous care in the balance of synchronous against induction motors in the operation of loads.

SYNCHRONOUS AND INDUCTION MOTORS.

It is a great mistake for an engineer to become an advocate of one motor to the exclusion of the other type. Both synchronous and induction motors have their spheres of usefulness, and practically every long distance transmission demands for its satisfactory regulation the use of both types. Where the powers are small and the loads easily started the simplicity of the induction motor and ease of installation render it especially suitable, but as their numbers increase the effect of the lagging currents they absorb becomes important in disturbing regulation, so that it soon becomes necessary to neutralize this lagging current either by the introduction of condensers or of synchronous motors.

With a synchronous motor it is possible to counteract the effect of large and variable inductive loads, and when they are installed in the sub-station at the delivery end of the line a ready and satisfactory means of controlling the voltage, whether it is disturbed by inductive or noninductive loads, is provided. Practice with these machines indicates, however, that they are still very useful if installed at points out of control of the sub-station attendants, provided only that their power of controlling voltage be not used maliciously, since they are generally most useful when the exciting current is adjusted to a minimum—a condition for which instructions are easily issued and of which the reasonableness appeals to the most ignorant attendant.

Much has been said and written of the resonant condition of a line, but up to the present time practice in the installation of plants and connection motors, transformers and other devices has not led to important interference from this source. What is called the resonant line, or distortionless line, can be obtained in two ways, either by the connection of capacities and inductances in series or by their connection in parallel. In the first method of connection there is a very serious rise of potential at the respective terminals of the capacities and inductances, but with the parallel connection no such rise is found. The series connection of capacities and inductances is rarely used, and principally on account of the difficulties likely to be encountered on account of these phenomena. The exact balance of inductances against the capacity of a line fifty or one hundred miles long, capable of supplying some thousands of kilowatts, would result in a voltage rise of not less than ten times the value of the normal; and when one considers that this normal may be anywhere between 25,000 and 50,000 volts it is easily seen that such resonance may be formidable. Such an effect is sometimes actually encountered in the operation of switches on lines where considerable cable lengths are used in feeding highly inductive apparatus. In a recent case an arc within a partially broken cable feeding rotary transformers, by raising the periodicity and producing apparently a resonant condition, caused the effect of most violent short circuits, blowing fuses with great violence and destroying both fuse holders and switches, currents appearing entirely beyond the capacity of the generating apparatus to maintain. When the proper inductances are connected in parallel, however, their action is beneficial to regulation and easy to handle, as has already been explained.

What has so far been said covers fairly well the question of purely electrical problems of regulation, and to call your attention to the essentials of the problem it only needs the summary that regulation in a long distance plant is attained by:

1. A wide possible voltage variation in the generators, with generators and transformers both designed, not for good noninductive load regulation, but for good inductive load regulation.

2. Lines designed for the smallest possible capacity current without reference to any attempt at balancing the line capacity against the load lag.

3. The use of reactance coils for balancing the constant capacity of the line.

4. The use of synchronous motors as a variable capacity for balancing the variable inductance of the line and the inductive motor load.

Of the elements of design which involve most nearly the question of continuity supreme importance attaches to the insulators, the switches and the lightning arresters.

To be sure the entire problem of continuity is also the whole problem of design. Everything must be built to withstand the strains, and the methods of accomplishing this are neither easy nor obvious; many of the well established methods of conveying and controlling water must be abandoned in favor of those which are more enduring. Open ditches and flumes are giving way to inclosed and lined trenches and tunnels.

For station structures the extreme of strength and fireproof character must be resorted to and the whole transmission line must be built for the greatest permanence. Spans are shortened even in some cases to only one-third of that used in telegraph and telephone construction. Heavier poles are employed, most carefully set and braced against even the slightest increase of strain. Rights of way are secured and cleared so that these transmission lines stand up against the storms and fires that lay waste the countryside.

INSULATORS.

But returning now to the purely electrical part of the problem, with which we are most directly concerned for the present, and directing our attention to the insulators, which present the first and most difficult problem, we find at the outset a royal battle waged between the insulating properties of glass and porcelain. In this country glass has for many years been the king of the insulators; abroad, for an equal period of time, porcelain has remained pre-eminent.

For potentials up to about 25,000 volts, where an insulator of 7 inches diameter is sufficient, there seems not much reason for the employment of anything except glass, unless the lines reach a size above ½ inch in diameter, when its strength is deficient. For these lower potentials and lighter lines the good properties of glass are easily summarized. In the first place it is cheaper by far; while not so strong as porcelain, it is, as has already been said, sufficiently strong for the purpose; its inspection is easier and surer, since it requires only a visual examination and a few taps of a hammer to ascertain its soundness in place of the tedious high potential test necessary in the examination of porcelain. But having said this much all has been said that is possible in favor of glass.

* From a paper read before the Boston Society of Arts at the Massachusetts Institute of Technology.

It is not true that glass is a better insulator than sound porcelain, nor is its surface so good in damp weather against surface leakage. The mechanical strength does not equal one-half that of porcelain, as has been proved by a long series of mechanical tests performed by dropping a steel ball from a height upon insulators of the two materials; temperature also affects it much more than porcelain, and it is often found to crack simply from the effect of extreme changes of temperature.

The insulators of high voltage lines must be very large, for the reason that with a striking distance through the air of from 4 to 6 inches great gaps must be provided in the path of the current. But above all a great creeping distance is essential.

Insulators that are a perfect protection in the hardest rains fail utterly in clear weather when covered by smoke or soot, which allow small amounts of currents to escape and char away the pins or cross arms. The compound insulator is very attractive, for the reason that it is easier and cheaper to make and handle two or three small parts rather than one large one, and in some cases the additional advantage has been sought of securing the good properties of both glass and porcelain by making parts of an insulator of each; but there is both a theoretical and practical fallacy in this type of design. In the first place, no dielectric is so strong as one entirely homogeneous. As the stress is passed from glass to porcelain, or *vice versa*, at the two surfaces the stress piles up as it were, and it is better if one believes in glass to rely upon it; or, on the other hand, to show faith in the porcelain used by employing it entirely.

From the pure standpoint of practice the insulator which must be cemented together is troublesome. The shrinkage of the mastic leaves voids and produces strains; if cement be used, its slowness in hardening delays the work and requires large areas for setting out to harden any considerable number of insulators. The one other mastic in use is molten sulphur, which, while better as a mastic than cement, is still more liable to crack the insulators while they are being joined, and, finally, when exposed to light and air, frequently decomposes on the surface, producing sulphuric acid; and, finally, when current creeps over its surface following the acid, perhaps catches fire and often results in the rupture and fall of the insulator. The insulator which will be entirely satisfactory for this use has not yet been found, but the diligent search made for it by some of our best engineers is resulting in its definition and will probably soon result in its production, not as an inspiration for a patent, but as a careful engineering conception.

SWITCHING DEVICES.

Switching and switching devices are most important and most difficult. Step by step the switch has improved in the electrical art from the simple commutator used by Faraday and Henry, which generally consisted of copper wire dipping into mercury cups, until, as you know, up to the present time a great amount of ingenuity devoted to the study has resulted in the production of elaborate and beautiful electrical and mechanical mechanisms. Switching for high powers, whether at low potential and great currents or at high potential and small currents, seems to be an altogether different art from switching where the spark that may follow can do but little destruction and its heat is readily dissipated. Almost all low power switches are designed with the idea that a spark may occur at the break, but as the energy of the spark is small the mass of the switch will carry away the heat, or the portion of the switch destroyed will be inconsiderable and may be easily replaced; but as soon as it becomes impossible to contemplate the destruction of a portion of the switch in the rupture of the current switching becomes impossible by such simple devices, the whole art of switching is changed and designs along entirely new lines must be produced. The great pneumatically controlled switches in the large power stations of New York and Boston exemplify this principle. Hardly anything in switching for small currents is similar. They are not simple switches, giants in size, but their method of operation is based upon a new principle and they involve in their construction much ingenuity and engineering study. As even the great switches with which you are familiar operate only on lines where the potential is comparatively low, the principles of high voltage switching need to be particularly called to your mind. In any high voltage transmission system, as, indeed, in any transmission system, the lines and loads contain not only resistance, but also capacity and self induction. The current flowing depends upon the E. M. F., the frequency and the constants of the circuit in an involved relation. A change in any one of these constants involves changes in the resultant current. A satisfactory switch must leave the circuit undisturbed as far as possible, and must introduce no new difficulties by reason of changed values of the constants. Furthermore, if a switch could be built which would simply instantaneously stop the current the effect would be an immediate and great rise of potential due to the sudden fall of current through the capacities and self inductions of the system. The open air switch, which in its essential particulars is simply that of the ordinary knife, or snap, switch as used for low potential, draws an arc at almost full current value, which arc, being rapidly oscillating in character, affects an increase of the periodicity on the line and thereby brings about great potential rise. We see, therefore, that a switch to be satisfactory on a high potential circuit must neither rupture the circuit too suddenly nor draw an oscillating arc. With ordinary switches in mind the rupturing of a circuit with these requirements in view seems to be almost an impossibility; and were there no means of introducing into the path of the switch blade high resistances which gradually reduce the current value and finally allow the stoppage of the flow of energy after it has become small in amount, we would have to provide in insulation of our long distance high potential lines materials which would withstand voltages from two to ten times the normal voltage. Of course no wire wound or carbon rheostat can be introduced into these switches, and the only resistances that are available are liquid and gaseous resistances. It is almost too soon to say that any particular type of switch has resulted from the experiments of the past two years which will be considered for all years to come the final type; but the successful work that has been done is along the line, as I have said, in the introduction of liquid and gaseous resistances. These resistances are the only ones that are high enough in value to be inclosed in the small space of a switch and which do not introduce additional complexities into the station system. The gaseous resistance is obtained in the oil switch by the carbonization of the oil as the switches open. Provided there be a sufficient amount of oil above the switch contact, so that as the circuit is opened the production of gas does not blow the oil out of the switch, a very satisfactory type of switch is produced, and one which our present experiments seem to indicate will gradually cause the rupture of a circuit without the production of excessive rise of potential.

The vaporization of metallic oxides has also been successfully used for this purpose, but when these oxides are vaporized in the switch it is difficult to retain them within the switch and they scatter their dust through the whole station. The liquid switch is one of the comparatively new developments and seems in many respects to be the best of all, since the liquid is always prepared as a resistance under all circumstances and does not depend upon the energy of the current to make it the imperfect conductor required. Therefore the disadvantage of the occasional failure of the switch from too rapid or too slow production of the vapor, as is the case with the vapor switch, is avoided. An incident in the difficulty of obtaining the proper switch for high potential working is the difficulty of insulating its moving parts and operating mechanism. Insulation materials of high dielectric strength are not ordinarily satisfactory mechanical materials. They are brittle, they are hard to work, often impossible to work, and are not readily obtained in exact form. Hence, many a switch that is entirely satisfactory from an electrical standpoint proves to be a failure on account of the difficulties with its mechanical support.

LIGHTNING PROTECTION.

Lightning protection for long distance transmission lines is, as one can readily see by the slightest consideration, of the utmost importance. Where a line passes over one hundred or two hundred miles of open country, dipping into the valley and rising to the tops of mountains, all sorts of weather conditions must be constantly encountered. A thunderstorm of small area is, in summer time, a matter of frequent occurrence; and we must consider that, as the line stretches way across the country many small areas of atmospheric disturbances may be and must be daily encountered. To be sure, as you all know, the lightning protection of a transmission line is not against strokes of lightning, but against the induced currents in the line by reason of neighboring lightning strokes. Furthermore, any transmission line must be protected against variation of atmospheric potential in clear weather. Experiments have shown that changes of elevation by a few hundred feet sometimes produce potential variation of many thousand volts, and these phenomena must be encountered and handled by the transmission engineer. One of the most effective devices that has been used is the erection of a continuous lightning rod along the entire line. For this purpose barbed wire, ground at the poles, has been employed. In some instances this has given trouble on account of the fact that the barbed wire used was inferior in quality and erected with unsafe strains; but when the wire has been carefully erected it is not necessarily a disturbance to the system, but a means of discharging the wire when the atmospheric potential varies and as induced current surgings are set up by neighboring lightning discharges. It is not by any means a settled principle with transmission engineers to install this barbed wire, though in the South, where the lightning disturbances are most frequent, it may be said that almost every line is erected with this protective device. Where it is not used reliance is placed altogether on the lightning arresters, through which the line may be grounded, these being installed either at the ends of the line or at the ends and at intermediate points; and even where barbed wire is employed such additional protective devices are absolutely essential, since the circuits themselves cannot be entirely freed from induced charges by any means, except inclosing them within a grounded metallic sheath, and this construction would, of course, be absurd and unmechanical. No mechanically operated lightning arresters are ever used for this purpose in alternating long distance transmission work, the devices employed being either of the nonarcing metal type or of a type where the air current produced by an incipient arc between the parts of the arresters blows out the arc before the machine current has an opportunity of following and effecting destruction. In some devices the combination of these two effects is to be found. These constructions of lightning arrester are old and well tried at lower potentials, but it is found that as the potentials rise the laws which seem to govern their action change materially, and no step has been made in raising the voltage without requiring material modifications of the rules for the installation of lightning arresters. Two thousand volt calculations have been found to fail altogether on 10,000-volt lines and these again to fail when the potential was raised to 25,000 volts, and finally with the doubling of that potential the previously ascertained rules seem to be altogether thrown to the winds and a new system of lightning protection made necessary. The final form in which this will be received by the engineering world has not as yet been established, but the experiments which have been tried up to the present time seem to indicate that a resistance or an impedance, or resistance and impedance combined, must be installed in the path of the ordinary lightning arrester in order to enable the induced charges on the line to pass away readily without noticeably increasing the effective line potential and without grounding and short circuiting the wires. The handling of this problem has been one of the last to be solved and one of the most troublesome questions involved in the engineering of transmission lines.

CONTEMPORARY ELECTRICAL SCIENCE.*

ZINC IMAGES.—P. Vignon, recently known through his researches on the Holy Shroud, describes the formation of images of reliefs by the "emanations" of freshly prepared zinc. Medals and bas-reliefs in plaster or other material coated with powdered zinc gave a negative image on a sensitive plate. This is due to the fact that the zinc vapor acts most powerfully at small distances. The action diminishes rapidly with increasing distance. The general impression is as if the object were seen through a mist, but for all that the delineation of the various outlines is more correct than that obtained by photography with illumination in the ordinary way. Similar impressions may be produced by the action of ammoniacal vapors upon linen impregnated with a mixture of powder of aloes and olive oil. The relief image of a plaster hand impregnated with ammonium carbonate and enveloped in a suede glove may thus be obtained. Such carbonate is produced by the fermentation of urea in many febrile affections. These facts are the basis of the author's sensational theory concerning the authenticity of the Holy Shroud.—P. Vignon, Comptes Rendus, April 21, 1902.

THE REICHSANSTALT.—The business done during 1901 in the Physikalisch-Technische Reichsanstalt included several works of electrical interest. Platinum resistances were standardized up to 500 deg., and found to be correct within 0.15 deg., whereas the error at the temperature of liquid air exceeds 2 deg. Small standard resistances of 0.1, 0.01, 0.001 and 0.0001 ohm were tested after several months' rest, and were found to have remained constant to within a few millionths of their values. The tests of the d'Arsonval galvanometer are nearly concluded, and the investigations concerning the Clark and Cadmium cells have been published. An important piece of work has been carried out with regard to the absolute temperature of a black radiating body, and the laws which put the total energy at a given wave length proportional to T^4, and the maximum energy proportional to T^5, lay the foundation of a new scale of temperature. Some analyses of fine spectrum lines have been carried out by Lummer and Gehrcke, with an extraordinary degree of delicacy by means of a new interference method utilizing the properties of a plane-parallel plate. The technological work included the examination of a number of electrical measuring instruments, chiefly wattmeters, and the testing of insulating materials and arc-light carbons.—Official Report, Zeitschr. für Instrumk., April, 1902.

DIFFUSION OF ELECTROLYTES.—If an acid containing an electrolyte is made to diffuse into a solution of the same electrolyte, the latter undergoes changes of concentration which at first sight appear somewhat surprising, but which are easily explained by the theory of dissociation. J. Thovert fills a test tube to one-third with a 0.4 solution of HCl, and the rest with a 0.39 solution of NaCl. After sixteen hours the concentration of NaCl at the top of the test tube has fallen to 0.384, and after forty-seven hours to 0.273, whereas it is increased in the lower portions. The same applies to KCl, and to a solution of nitric acid diffusing into a solution of silver nitrate. But when the lower solution consists of sulphuric acid and the upper of HCl, the latter is driven up instead of down, and its concentration increases at the top instead of at the bottom. According to the osmotic theory, if an electrolyte is split up into ions, osmotic pressure, working against different ionic frictions, would cause a separation of the components if the solution has layers of different concentration. Hence, electric forces are brought into play, leading, in the first case quoted, to an increase in the velocity of the H ions, and a retardation of the Na ions, so that the latter are crowded out at the upper surface.—J. Thovert, Comptes Rendus, April 14, 1902.

FARADAY EFFECT.—The effects of rotary magnetic polarization have lately received increased attention in view of the light which they throw upon the motions and distribution of ions in dielectrics and electrolytes. Siertsema recently extended the magneto-optic dispersion curve of potassium ferricyanide till close upon the limit of absorption. H. du Bois maintains that the Faraday effect is either positive or negative for the compounds of the different metals of the erbium series. The salts of cerium, praseodymium, neodymium, samarium, gadolinium, erbium and ytterbium are strongly paramagnetic, and the absorption spectra of cerium, gadolinium and ytterbium show peculiar lines and bands, concerning which we have an extensive literature. H. du Bois believes that researches made upon these three metals in connection with the magnetico-optic properties are bound to yield valuable data for theoretical progress. He has not yet succeeded in finding any effect of a magnetic field upon the very characteristic absorption spectrum of the strongly magnetic erbium chloride solution. Experiments should be made, if possible, upon the absorption bands themselves.—H. du Bois, Ann. der Physik., No. 4, 1902.

VALIDITY OF OHM'S LAW.—The law enunciating the proportionality of a current to the ratio of the E.M.F. and the resistance in the circuit must now be expressed in terms of the known properties of the ions whose motions constitute the current. J. Stark formulates the equation

$$J_n = n_n \varepsilon v_n X,$$

where J_n is the current density of the negative ions, ε their charge, v_n their specific velocity and X the force moving them. The same author now shows that the limit of the validity of Ohm's law is reached as soon as the difference between the driving forces at the beginning and at the end of the mean free path ceases to be small in comparison with the driving force itself. This may happen whenever, owing to some sudden change of medium, there is a surface accumulation of ions producing a strong electric field, or where, owing to exhaustion, the mean free path of the electrons is of visible length. It is well known that in the vacuum glow discharge the electric force

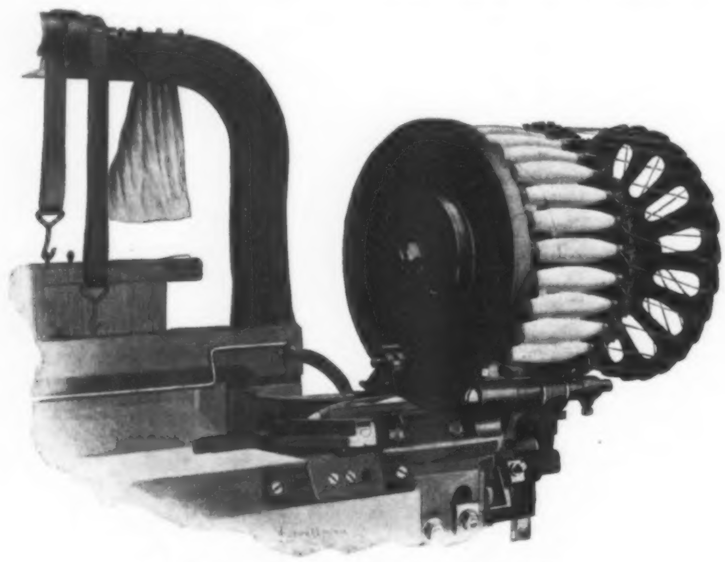
* Compiled by E. E. Fournier d'Albe.

is very great immediately at the cathode, whereas in the negative glow light it is little more than zero. This distance between the cathode and the negative glow light is smaller than the mean free path of the negative ions. There is, therefore, a steep slope of electric force just in that locality, and hence, also, the well-known invalidity of Ohm's law in the same place.—J. Stark, Ann. der Physik, No. 4, 1902.

THE NORTHROP LOOM.

By IRVING U. TOWNSEND.

FOR more than fifty years preceding 1890 there was no radical improvement in looms. Common looms were improved in design and detail, and in fancy weaving there was much progress, but the old principles and defects were adhered to. The loom of Richard Roberts, of 1830, had the same relative position and construction of all the parts as that of 1890. It is claimed that the Roberts loom with slight changes in certain weights and proportions could weave ordinary cloth as rapidly as that of 1890.



THE HOPPER AND ADJACENT PARTS.

Throughout this period it was foreseen that a radical change in weaving, comparable to that of Whitney in ginning, would occur upon the invention of a simple and effective weft replenishing mechanism. In 1840 attempts were made to change shuttles automatically upon the failure of weft, and prior to 1870 more than forty patents, mostly British, were issued for weft replenishing or for warp stop mechanisms. None of these weft replenishing devices came into general use.

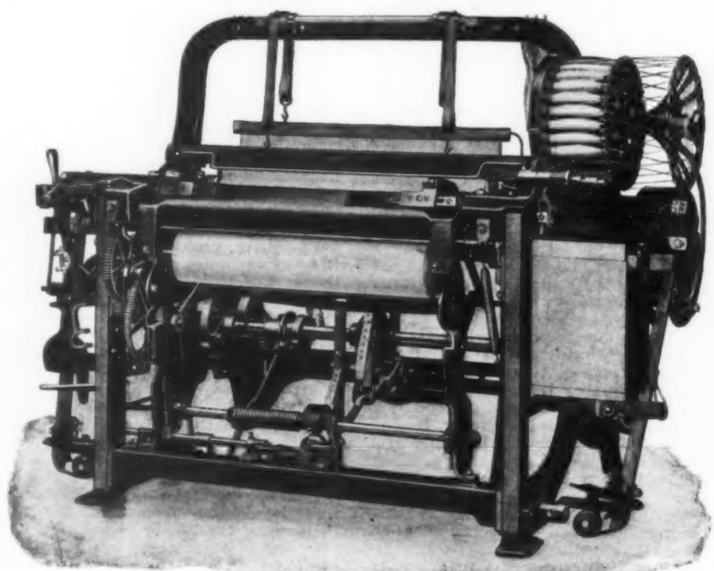
In 1888 the firm of George Draper & Sons, of Hopedale, Mass., began experimenting with weft replenishing devices. For nearly seven years these experiments were carried on before looms were built for the trade. The best inventive skill was employed; an experimental weaving room of sixty looms was established, and more than $1,000,000 were expended in perfecting what is now known as the Northrop loom, before a single dollar was received in return.

The immense prize at stake fully warranted this lavish expenditure. To realize this it is necessary to appreciate the cost of weaving. Before the advent of the automatic loom, the cost of labor in the weaving department represented 50 per cent of the whole labor cost of cloth production and amounted to $40,000,000 per year in the United States in cotton mills alone. George Draper & Sons sought to cut in two the cost of weaving. If they should succeed in wholly introducing a loom accomplishing this result, the saving would be nearly enough to pay the interest upon the national debt.

In an ordinary loom the weft breaks or becomes exhausted every five minutes on an average and about twenty warp threads break daily. Whenever the weft fails the loom stops through the action of the weft fork, which upon each forward motion of the lay feels for the weft. Then the shuttle must be taken out, another put in its place, the loom started, the empty bobbin taken out of the discarded shuttle and a new one placed upon the spindle, the end of the filling sucked through the shuttle eye (a practice often resulting in a few years in consumption) and the shuttle placed in a holder. As an average weaver attends eight ordinary looms, this series of operations must be performed 960 times daily. In addition, the twenty broken warps per loom must be mended. The working day is ten hours, of which half an hour is required for cleaning, oiling, etc. If the weaver tends eight looms he must every half minute visit one of them and perform the series of operations described or piece a broken warp. The state of affairs is really worse, as the looms may run without interruption for several minutes and then several need attention at once.

The firm first made experiments in changing shuttles, an idea old in itself, but not then successfully worked out. In 1890 James H. Northrop, one of the firm's inventors, conceived the idea of changing the bobbin in the shuttle rather than the shuttle. There are three methods of replenishment, namely, changing shuttles, changing the bobbin or other carrier in the shuttle, or changing a case in the bobbin carrying a weft supply. To change the bobbin required an entirely new construction of shuttle, open at top and bottom, now known as the Northrop shuttle. Formerly the bobbin was held upon a spindle pivoted in the shuttle. Northrop omitted the spindle and provided the base of the bobbin with rings or corrugations, which were grasped by grooved plate springs within the shuttle. As an alternative, he provided a cop skewer with rings, the bobbin being placed upon the skewer.

The Northrop loom is provided with a rotating hopper containing 14 bobbins grasped at each end and mounted upon one end of the breast beam in such position that when the lay beats up and the shuttle is in its box the bottom bobbin in the hopper is directly above the bobbin in the shuttle. In the most recent constructions the hopper contains 25 bobbins. Originally this loom was arranged to replenish upon failure of weft, either breakage or exhaustion, to be detected by the weft fork, which instead of acting to stop the loom as formerly, operated to raise a notched dog attached to a hammer pivoted in the hopper. The dog when raised comes in the path of a bunter on the lay, which on the next forward movement pushes the dog, turning the hammer and knocking the bobbin out of the hopper into the shuttle, thereby ejecting the spent bobbin through the bottom of the shuttle, provided a protector finger indicates that the shuttle is in proper position to receive the bobbin. When the lay moves back the shuttle is thrown and the bobbin thread, whose end is attached to the hopper, is guided automatically into the eye of the shuttle through a slot so shaped as to retain the thread. Each time a bobbin is ejected the hopper rotates one step, bringing another into position. The threads extending from the hopper to the bobbins are automatically severed after each bobbin is brought into use. A cutter also severs the yarn end of the discarded bobbin.

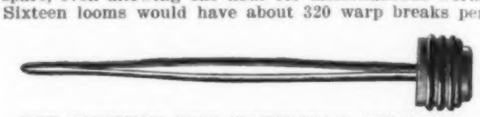


THE NORTHROP LOOM.

The problem of bobbin replenishment would be difficult enough if the shuttle were thrown at a low speed, but when it is understood that in the modern loom it is thown 180 or 200 times a minute, and that the spent bobbin must be ejected and a filled one inserted without stoppage or slowing down, the difficulty of the problem can be somewhat appreciated. At 180 picks a minute the shuttle rests in its box somewhat less than one-third of a second. Moreover, the box is not stationary, but moves with the lay at right angles to the throw of the shuttle. Replenishment must occur at the precise instant the lay is forward adjacent the breast beam and while the shuttle is in its box. Success seems almost impossible under these conditions. The writer has often stood over a loom, and although on his guard to observe the action of replenishment, could barely detect that anything had occurred, and much less could he trace the steps of the action.

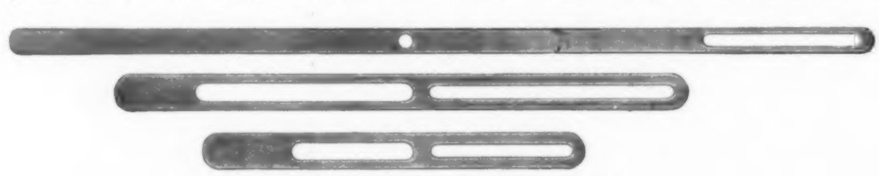
BOBBIN FOR NORTHROP SHUTTLE.

A weaver formerly tending eight common looms can tend sixteen Northrop looms and still have time to spare, even allowing one hour for miscellaneous work. Sixteen looms would have about 320 warp breaks per day, consuming not quite 3 hours to repair. As the hopper contains 14 bobbins, each lasting five minutes, the weaver is required daily to fill 137 hoppers, which at a minute and a half per hopper would consume 3 hours and leave nearly 3 hours unoccupied. Some weavers run 20 or 24 Northrop looms, a few run 30 and there are several records of 40 looms run successfully by a single operative. An old weaver has much to unlearn when he takes charge of a Northrop loom. The hardest thing to overcome is the tendency, born of a habit of years, to watch the looms. His duties are reduced to placing bobbins in the hoppers and piecing broken warps.

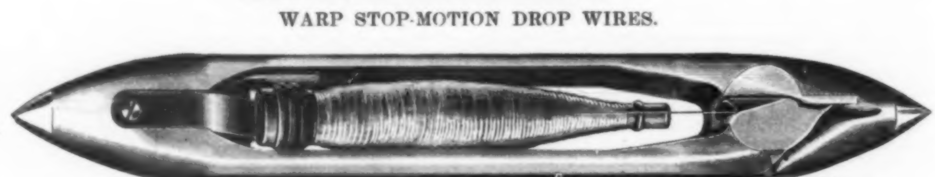


COP SKEWER FOR NORTHROP SHUTTLE.

Weavers are paid by piece work. The Northrop loom halves the labor of weaving, which is itself one-half the entire mill labor of producing the cloth. The saving in the cost of weaving is more than the entire cost of carding with the picker room added and more than the cost of spinning. The labor cost in a pound of print cloth (7 yards to the pound) has been decreased from 5.728 cents to 4.35 cents. There must follow a proportionate decrease in the price paid for weaving. In the Queen City Mill at Burlington, Vt., there are 792 Northrop looms and the price per cut is



WARP STOP-MOTION DROP WIRES.



THE NORTHROP SHUTTLE.

9 cents, whereas in Fall River, using old looms, it is 18 cents. Yet the weekly wages of the weavers at the Burlington Mill equal those at Fall River and exceed them when more than 16 looms are tended. If all the old looms could be replaced at once by Northrop looms, half the weavers would be thrown out of employment, but as it would take 20 years to replace the old looms, considering the demands from new mills, it is evident that the gradual change will hardly be noticed by the weaving class.

The Northrop loom is equipped with warp detectors which are flat wires, one threaded upon each warp, so that when a break occurs the dropping wire stops the loom. Although this in itself is a very old expedient, the common loom does not stop upon the breaking of a warp, since in the class of goods woven upon it the cloth buyer expects such defects. Hence to economize time the weaver would let a broken warp thread go until the loom was stopped automatically by the breaking of the weft. It would have limited production to have applied warp stop motions. It was found that the weaver tending a Northrop loom, although greatly relieved of manual labor, was subjected to great mental strain on account of possible "overshots" resulting from broken warps in 16 or more looms. It became absolutely necessary to introduce the automatic warp stop upon the Northrop loom. This feature in itself obviously cannot increase the production, whether upon the Northrop or an old loom. The automatic replenishing feature of the Northrop loom doubles the capacity of the old loom. Yet when these two features are combined the capacity is tripled. This is a paradox very difficult to explain, yet its truth has been established beyond contradiction and it is the basis of a broad patent for the combination. Moreover, the cloth is of a higher standard, with less seconds, owing to the use of the warp stop motion. Thus equipped, the looms are permitted to run through the noon hour without attendance, and at its close 70 per cent are still in operation.

The original Northrop loom replenished when failure of weft was indicated. The fork could not act quickly enough to cause new weft to be placed in that particular "shed" of the cloth in which the failure occurred and thus a thin place in the cloth resulted. After years of labor the Drapers evolved what they term a "feeler," which in one form or another is in very general use. It consists of a finger placed upon the side of the loom opposite the hopper and which every time the lay moves forward passes into the shuttle and feels how much weft remains. When it has reached a stage of "practical exhaustion," that is, when the bobbin has thread enough for only two or three picks, the feeler sets in motion the replenishing mechanism, thus preventing a thin place in the cloth. The yarn left on the discarded bobbin is used for waste or for piecing up in the spinning frame. If the weft should break the fork acts to replenish as before.

Another problem worked out was that of stopping the shuttle at a definite point in its box. The tendency of a shuttle's entering its box at terrific speed is to rebound before the binder can act. The shuttle must be held so that its bobbin is directly under the lowest bobbin in the hopper, for otherwise a new bobbin forced down in the act of replenishment would not be engaged by the springs in the shuttle. Only about one-quarter of an inch rebound can safely be permitted. Replenishing mechanism is being applied to looms having shifting shuttle boxes and employing different colored threads. When any thread is exhausted a new bobbin containing the proper color is supplied.

The growth of cotton mills in the South is marvelous. In 1899 they consumed about 1,500,000 bales, or 39 per cent of the American consumption and one-eighth of the American crop. In 1890 these mills used but 480,000 bales and in 1880 but 186,000. The number of cotton spindles in the South is at present more than 4,000,000. In 1890 it was 1,500,000 and in 1880 but 500,000. The new mills of the South are a most fruitful field for the Northrop loom. Up to January 1, 1900, there had been 42,515 complete Northrop looms sold, of which 25,000 went to the Southern States. All but a thousand went to North Carolina, South Carolina and Georgia. South Carolina led with 17,426. In 1900 over 16,000 looms were shipped. The total sales, including old looms changed over, now considerably exceeds 70,000. Three years ago the works of the Draper Company were very greatly enlarged, and over 3,000 men are now employed in manufacturing these looms.

As a commentary upon the development of weft replenishing looms, it may be stated that prior to 1890 there were only about half a dozen United States patents upon such looms. At the present time there are about 175 patents in the sub-class—weft replenishing—of which more than 90 belong to the Draper Company. In the related sub-class of warp stop motions there were, prior to 1890, but a few more than half a dozen, while now there are about 160, of which more than 50 belong to this company. There are other subclasses in which are many more patents directly relating to weft replenishing that very materially increase these remarkable figures.

AUTOMATIC CARVING MACHINES.

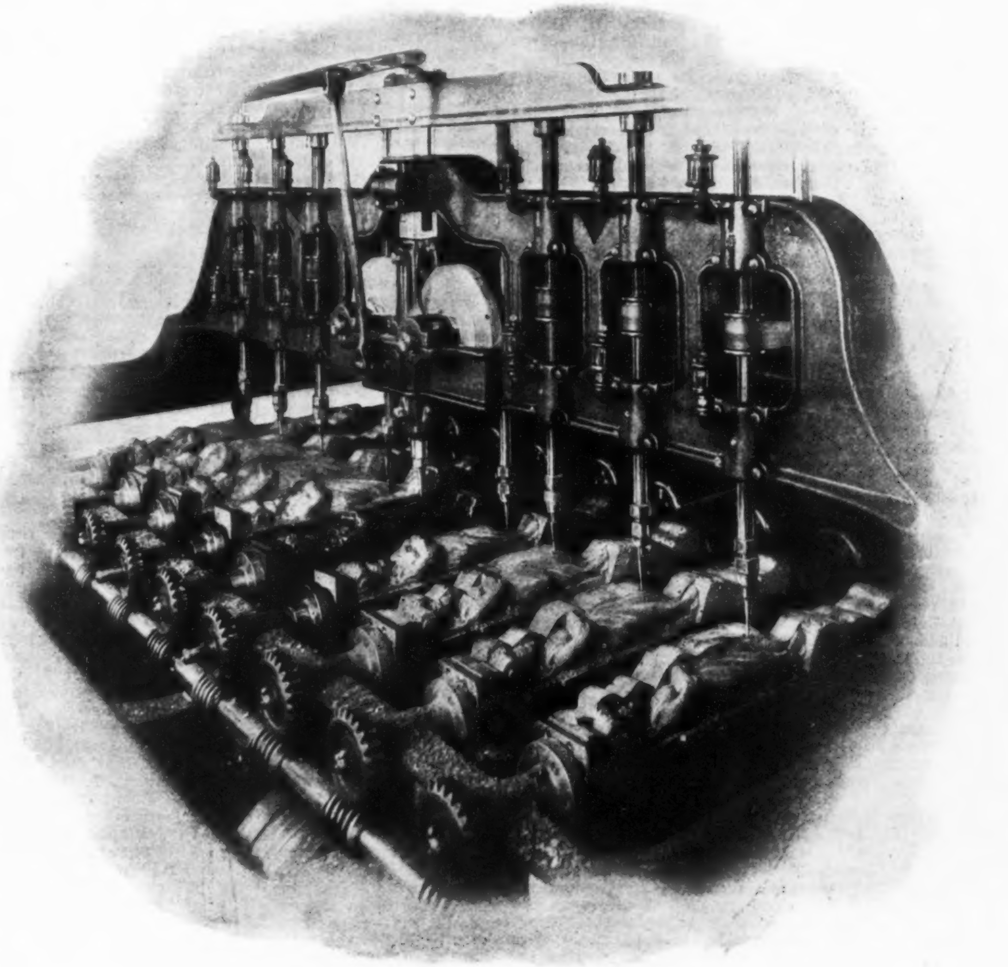
In keeping with the times we are not surprised to learn that carving is now done with automatic machines. On the contrary, the wonder is that such a machine was not designed long ago. The woodworking industries have been somewhat behind other trades in the invention and adoption of automatic machinery. Most woodworking mechanism requires such constant attention and supervision that it is necessary to employ an operator for each machine. A marked departure from these antiquated methods will be observed in the new carving machine which we illustrate herewith. Not only is this machine perfectly automatic, but it is, at the same time, very simple in construction, having no complicated parts to become disarranged and require skilled attention.

The illustration shows very clearly how the operations are effected. The center work is a metal pattern which rotates and moves back and forward under a tracer point. The wood blocks to be carved are similarly moved, and each cutter, over its respective block, duplicates the movements of the tracer. The pattern and blocks are all mounted on a table which slides back and forth in ways on the main frame, just as the table of a machinist's planer travels, but with this difference, namely, that the table moves with a uniform motion in each direction because the tools cut both in going and coming. The machine is, therefore, working continuously and no time is lost in the return of the table. Suitable means are provided for automatically reversing the motion at the end of each cut, and this reversing device may be easily adjusted to any length of cut desired. For work on a center, such as that illustrated, the pattern in each block is given a rotary motion at the end of each cut, thus presenting a fresh portion to the tracer and cutters for the next cut. This rotary motion is imparted by means of suitable gearing, as shown in the engraving. By an easy adjustment which takes but a moment's time, the machine may be adapted for panel work, in which case instead of a rotary movement the pattern blocks are automatically shifted at the end of each cut.

The center pattern is made of cast iron, and because of the excellent casting now done, an accurate duplicate of a carving can be made for but a few cents per pound, which is ready for the machine as soon as it arrives from the foundry. This is a great economy, for the original wood carving may be used to fill an order, it having been replaced by a permanent, indestructible pattern which cannot be destroyed by fire.

The machine shown in the engraving is adapted to cut eight blocks at a time, the pattern here being 24 inches long by 5 inches wide. The time required for carving a set of blocks varies, of course, with the dimension of a pattern. In this case the time consumed in setting the work was fifteen minutes and the entire eight carvings were completed within one hour and forty-five minutes. Duplicate patterns can be easily obtained at a slight cost, and it is, therefore, advisable to cut two or more carvings at a time under each cutter whenever the dimensions of the pattern permit. The carvings under each cutter may be done on a single block of wood and band-sawed out when completed, thus saving the many handlings of a lot of small pieces until after the product is completed.

Only two styles of bits are used for all variations of the work, namely, spoon bits and three-lipped cutters. No high-priced mechanic is, therefore, needed for the selection of a hundred and one different styles of cutters, nor is it necessary to waste the valuable time of an expert to keep them in repair. The machine is simple throughout. All the operator needs to do is to set the work and start the mechanism, whereupon the latter performs its duties without requiring further attention until the carvings are completed.



CARVING BY AUTOMATIC MACHINERY.

A SUBSTITUTE FOR SHEEP'S WOOL.

At Dusseldorf has been discovered a means of using peat fiber. It is stated that a fiber has been produced capable of being spun, which is absorbent, and which can be bleached and dyed. The vegetable fibers were first isolated, and treated with acids and alkalis, the result being a peat wool consisting of nearly pure cellulose. This turf wool is soft, elastic and capable of being spun in the same way as sheep's wool.

With the addition of cotton or sheep's wool, yarn can be spun which is useful for various clothing fabrics. The quality of absorption which it possesses renders it very suitable for summer wear, and the same may be said for its warmth in winter. The felt manufacturer uses it in the production of peat-felt hats. If the inventor is successful in reducing this peat yarn to a still finer thread it will perhaps find great use in hosiery manufacture, for which, as it is a bad conductor of heat, is absorbent and cheap, it is especially suitable. Not only dress stuffs, but carpets and other such like goods, which are capable of being bleached and dyed, are stated to have been produced. Peat wadding is said to be specially valuable for sanitary and surgical purposes, keeping wounds clean and dry.

ROYAL SOCIETY REPORT ON THE WEST INDIAN ERUPTIONS.*

The Soufrière mountain forms the northern extremity of St. Vincent, and its general form at once suggests a comparison with Vesuvius. It is a simple cone without lateral or parasitic craters. The one at its summit is surrounded on the north side by the remains of a gigantic crater ring, which has the same relation to the present crater as Somma has to Vesuvius. On the northeast lip of the main crater there is a smaller one known as the New Crater, as it is believed to have originated in the eruption of 1812. It is only one-third of a mile in diameter. It is doubtful whether the New Crater was active during the late eruption, and there can be no doubt that it was from the principal crater, or "Old Crater," that the materials mostly were emitted. Deep valleys, often with precipitous sides, have been cut in the slopes of the mountain, especially on its southern side, and it is in these—and particularly in the Wallibu, Rozeau and Rabaca Dry River—that the greater part of the ejecta of the recent eruption has collected.

PREMONITORY SIGNS OF ACTIVITY.

The eruption of May, 1902, though sudden in its outburst and disastrous in its effects, was far from unexpected. In the north of St. Vincent there were two settlements of the aboriginal Caribs, and these had been so startled by the frequent violent earthquakes that in February of last year they were considering the advisability of deserting the district. But the first signs of active volcanic activity were on Tuesday, May 6. The inhabitants of the leeward side were fortunate in having a clear view of the crater, and warned by the outbursts of steam they fled to Chateaubelair and other places along the coast-line to the south, so that few lives were lost in this quarter. But, on the windward side, the summit of the mountain, as is frequently the case, was wrapped in cloud. Here, at the base of the mountain, there is an extensive stretch of flat land, known as the Carib country, on which were situated some of the largest and richest estates on the island, with a dense population, mostly black or colored. So little alarm was felt here, that even on the morning

* Abridged from a preliminary report by Dr. Tempest Anderson and Dr. J. S. Flett, just published in the Proceedings of the Royal Society, vol. lxx., pp. 423-445. See Nature, Vol. 66, No. 1712.

of Wednesday, May 7, when the leeward side was practically deserted, sugar-making was in progress on several estates, and all the operations of tropical agriculture were being conducted as usual. From Kingstown, telephonic messages were sent to Georgetown, which is not far from the base of the hill, stating that the Soufrière was in eruption, but they appear to have occasioned little anxiety. And when, about mid-day on Wednesday, the danger was too obvious to be overlooked, the Rabaca Dry River, and some of the streams on the windward side, usually dry except after rains, were running boiling hot, and could not be crossed. Many fugitives in this way found their escape cut off. It was here that the loss of life was greatest, which, though many escaped, is estimated to have amounted to 2,000, including about a dozen white men—the overseers of the plantations. The exact number will never be known, as many were entombed in the ashes where they fell.

PROGRESS OF THE ERUPTION.

About mid-day on May 6 the first signs of the eruption were observed by those dwelling on the southwestern side of the mountain. At 2:40 that afternoon there was a considerable explosion, and a large cloud of steam ascended into the air. By 5 o'clock a red glare was visible in the steam cloud on the summit. Activity continued during the evening, and at midnight there was a great outburst, and red flames were noticed on the lip of the crater. Next morning from Chateaubelair a splendid view could be obtained of gigantic mushroom-shaped clouds rising to a great height in the air—estimated at 30,000 feet—and drifting away before the northeast trade wind. As the day advanced the eruption increased in violence; by 10:30 A. M. enormous clouds of vapor were being emitted with loud noises, accompanied by much lightning. It is remarkable that at that time the inhabitants of the windward side were still in doubt about the reality of the eruption, since they mistook the dark cloud covering the mountain for a thunder cloud. The mountain was now in a state of continuous activity, and from Chateaubelair it could be seen that the materials were mostly discharged from the old or principal crater. Vast clouds of steam, showers of dark matter (probably mud), and of stones, could be seen projected from it, partly on the leeward, but mostly on the windward side. At mid-day the slopes of the mountain were still green, and the rich mantle of tropical vegetation had not yet been destroyed. A thin layer of fine ash had fallen over the lower ground, only sufficient to give the leaves a grayish color. The enormous columns of vapor continued to ascend from the crater, with frequent violent outbursts, projecting showers of stones and mud.

About this time it was noticed that steam was rising from some of the valleys on the south side of the hill, and this increased until at 12:50 the whole mountain was suddenly enveloped in a dense cloud of vapor. Just before this the rivers Wallibu and Rabaca had been seen rushing down in raging floods of boiling water. It was most probable that these phenomena were due to the escape of the crater lake, which was driven over the lower or south lip of the crater between 12 o'clock and 1 o'clock on the Wednesday afternoon, and poured down the valleys to the sea. So far as we know there were no mud lavas, in the ordinary sense, flowing down these valleys, but only a tremendous rush of boiling water, which left no traces which we could recognize when we visited the district.

By 1 o'clock the roaring of the volcano was tremendous. Showers of stones were being projected both to windward and to leeward. The enormous columns of steam continued to ascend from the crater. The lightnings were terrific, and after the large outbursts, which took place every few minutes, volumes of vapor might be seen covering the whole area. Hitherto the eruption had been of a type with which geologists are familiar, and the destruction done was confined to the higher parts of the mountain in the close vicinity of the crater.

But about 2 o'clock—to quote the words of an eyewitness (Mr. T. M. McDonald, of Richmond Vale Estate)—"there was a rumbling and a large black outburst with showers of stones, all to windward, and enormously increased activity over the whole area. A terrific huge reddish and purplish curtain advanced to and over Richmond Estate." This was the strange black cloud which, laden with hot dust, swept with terrific velocity down the mountain-side, burying the country in hot sand, suffocating and burning all living creatures in its path, and devouring the rich vegetation of the hill with one burning blast.

THE HOT GASES AND DUST.

On the leeward coast few were overtaken by the black cloud, as the inhabitants had fled and taken refuge in the villages south of Chateaubelair. Those who were caught were killed or badly burned. One boat was near Richmond at the time the blast swept down. The occupants describe the heat as fearful. Hot sand rained into the boat, and the sea around was hissing with its heat. The darkness was so complete that a man could not see his hand. They saved their lives by diving into the water; when they returned to the surface the air was suffocating, but they continued to dive again and again, and, when at their last gasp, they found that the air cleared, they could breathe again. This occupied only a few minutes—probably much less in reality than it appeared to them. One man was too exhausted to continue diving; he clung to the gunwale of the boat, and the tops of his ears were severely scorched.

On the windward side of the island an uninterrupted view of the progress of the eruption could not be obtained, owing to the veil of cloud which obscured the summit. By mid-day on Wednesday even the most skeptical were convinced that the Soufrière was in eruption, and that the noises heard continuously were not due to a thunderstorm. Before mid-day there had been very heavy rain-showers, and it was noticed that the raindrops carried down fine particles of ash. Work ceased on the plantations, and those laborers who still remained endeavored to escape to Georgetown or shut themselves up in their houses. By 2 o'clock fine ashes, with occasional larger stones, were falling steadily, but, as yet, little damage had been done, and no one had been injured. Then came the climax of the eruption, and those who were in the open air saw a dense black cloud rolling with terrific velocity down the mountain. They took refuge in their houses and in the plantation works, where they crowded together in such numbers that in one small room 87 were killed. The cloud was seen to roll down upon the sea, and was described to us as flashing with lightning, especially when it touched the water. All state that it was intensely hot, smelt strongly of sulphur, and was suffocating. They felt as if something was compressing their throats, and as if there was no air to breathe. There was no fire in the ordinary sense of the word, only the air was itself intensely hot and was charged with hot dust. The suffocating cloud only lasted a few minutes. Those who survived this ordeal mostly escaped, though many died within a few hours from shock, or from the severity of their injuries. In some cases a few survived, entirely or almost entirely uninjured, in a room in which many others died. Most of those who escaped had shut themselves up in the rum cellars or in substantially built houses, and had firmly closed all doors and windows. By the time the hot blast had reached the coast the sand it contained was no longer incandescent, and though still at a very high temperature it did not set fire to wood or burn the clothes of those exposed to it. The burns on the survivors were chiefly on the outer aspect of the arms and legs, and on the faces, and confined to parts not protected by their clothes.

THE RAIN OF DUST.

Complete darkness now covered the whole north end of St. Vincent—a darkness more intense than any of the inhabitants had ever before experienced. The fugitives had to creep along the roads or feel their way along the roadsides. The roaring of the mountain was terrible—a long, drawn-out, continuous sound resembling the roar of a gigantic animal in great pain. Fine ash and sand rained down over the whole country with occasional showers of large stones. Some of these were so hot as to set fire to the trash roofs of huts in the south end of Georgetown, at a distance of seven miles from the crater. In Kingstown, twelve miles from the Soufrière, the ash was at first moist, but afterward dry. It had a strong sulphurous smell, and pattered on the roofs like a heavy shower of tropical rain. Around the volcano the earth shook and trembled continuously, and the motion was described to us as undulating rather than resembling the sharp shock of an earthquake. Only in one or two cases were the walls of houses injured. What was taking place on the summit of the mountain no one can tell, but all who passed that night in the vicinity of the Soufrière agree that there was one black suffocating cloud, and only one. In all probability the eruption had reassumed the ordinary phase, and the showers of ash and stones were produced by violent upward explosions of steam. By half-past 5 o'clock the ash was falling in Barbadoes, one hundred miles to the eastward, whither it had been carried by the upper currents of air in a direction opposite to that of the trade winds. In St. Vincent the darkness lessened slightly before nightfall, but the rain of dust and the noises lasted until early in the ensuing morning.

When day broke it was seen that in St. Vincent, and even in Barbadoes, everything was covered with fine gray ash resembling a fall of snow. The dust had penetrated into the interior of the houses, where it lay in a thin film on walls and furniture. In Kingstown there were stones as large as a hen's egg; in Georgetown and Chateaubelair some had fallen as much as one foot in diameter. Little damage, however, appears to have been done to growing crops, except in the north end of the island. In fact, many believe that the sulphurous ash had insecticidal properties, and benefited the vegetation. From Chateaubelair it could be seen that the volcano was still emitting puffs of slaty-colored steam, and showers of fine dust were falling on the leeward side of the mountain. For several days these discharges of vapors continued, but a new phenomenon now attracted more attention. The ravines which furrow the south side of the mountain were found to be discharging clouds of vapor, and this gave rise to reports of fissures having opened on the flanks of the Soufrière, of subsidiary eruptions arising from these fissures, and of streams of lava flowing down the valleys. As a matter of fact, they were really due to the action of water flowing through the hot sand, which in some places had almost obliterated the old stream courses, as will be explained more fully later on. By May 15 the volcanic activity had apparently subsided, and the mountain remained clear and unclouded. The explosions of steam in the valleys continued and are probably still going on.

The state of quiescence continued until Sunday, May 18. Confidence was being restored, and the inhabitants of those districts near the mountain which had not suffered severely were returning to their homes. On the windward side the work of burying the bodies had been completed and things were resuming their normal course. But about 8 o'clock that evening an ominous sound was heard from the crater. Its nature was at once recognized and struck the black population with terror. The noises were as loud as those of the first eruption, and the lightning was very vivid. On the leeward side complete darkness prevailed, and ashes and sand fell freely for some hours. In Georgetown the fall of ashes was quite inconsiderable, not exceeding a thin film on the roofs of the houses. Gradually the noises lessened, the darkness lifted, and the moon appeared again. No lives were lost and practically no damage was done, but exactly what happened on those parts of the mountain nearest the crater it is, in the circumstances, impossible to say. This second eruption was the last which proceeded from the main crater. Clouds of steam were sometimes seen gently rising for some days later, but nothing of the nature of a volcanic outburst has since taken place.

PRODUCTS OF THE ERUPTION.

We arrived at Kingstown on Tuesday, June 10, and proceeded at once to Chateaubelair, where Mr. James E. Richards, of Kingstown, kindly placed a house at our disposal. The geological products of this eruption proved to be of very simple character. The Soufrière and the surrounding country were covered with a layer of ashes mostly in the form of fine dark-colored sand, but mixed with spongy bombs of various sizes and many ejected blocks composed of fragments of the old rocks of the hill. Lapilli and scoria are there in plenty, as is obvious where the heavy rains have washed away the finer material, but the greater part of the ejecta consists of fine sand which, when dry, is hot and yellowish-gray in color, but when wet becomes almost black. This sand, as has already been noted by many observers, contains plagioclase felspar, hypersthene, augite, magnetite and fragments of glass, and represents a fairly well-crystallized hypersthene-andesite magma which has been blown to powder by the expansion of occluded steam.

The coarser material is mostly a slaggy andesite with crystals of plagioclase and pyroxene. There is little pumice, though we obtained a few fragments which floated on water and contained but few crystals visible to the naked eye. The larger bombs are often black, highly lustrous and glassy when broken across. Some were seen at Wallibu (four miles from the crater) three feet in diameter. The ejected blocks consist of weathered andesites and andesitic tuffs such as can be seen in the walls of the crater. They are very numerous, and some are more than five feet across. In addition to these, fine-grained dark green banded rocks occur, which appear to be baked and indurated sediments, probably the mud from the bottom of the crater lake, or the finer beds intercalated in the older volcanic series. Another type of ejected block which is very common in some parts of the hill is a coarse-grained aggregate of felspar, hornblende (brown under the microscope), and perhaps olivine. It is not vesicular, and contains little or no glass, being apparently holocrystalline. These rocks are very friable, and the crystals are loosely aggregated together. They seemed to us to be comparable to the sanidinites of the Eifel and many other modern volcanic districts. They are certainly quite unlike true plutonic diorites, both in their structure and in the character of their minerals.

It may be noted that none of these rocks are characteristic of this eruption, but all can be found among the older materials of the hill. The hardened, baked sediments were well known to the Caribs, who have long used them for the manufacture of their finer stone implements. The felspar-hornblende blocks were found by us among the older rocks, and in some places even as rounded masses enveloped in the old lavas. Some of the fresher bombs in the river beds and the seashore can hardly be distinguished from those which were the product of this eruption, though undoubtedly of much older date.

The conclusion was forced upon our minds that immense quantities of hot sand had rushed down the hill into these valleys in an avalanche which carried with it a terrific blast, and piled the ashes deep in the sheltered ravines, at the same time sweeping everything off the exposed ridges which lay between. The rain of volcanic material, which lasted for hours after the hot blast had passed, then covered the surface of the country with a final sheeting of fine dust and scoriæ.

EFFECTS PRODUCED BY THE HOT BLASTS.

When we ascended the Soufrière, the evidence of the passage of a hot blast laden with sand was overwhelmingly clear. The various stages of its action, and its varying intensity at different spots, are most easily observed on the windward side, where the country is more flat and open, and there are fewer ravines and spurs to modify the course of its operations than in the Wallibu Valley.

The track to the summit passes across the Rabaca Dry Valley near the shore, then turns upward through the sugar-cane fields of Rabaca and Lot 14. These were covered with three or four feet of sand and scoriæ, the trees all bare, their leaves stripped by the falling cinders; but few branches were broken, and no trees had been uprooted or cast down. The woodwork of the houses was unburnt, though the roofs of some of the verandas, and of the laborers' huts, had collapsed from the weight of ashes that had fallen on them. Many people were killed on these estates. The survivors described to us how the dark cloud had rolled down from the mountain, and how hot and suffocating the air had been when it enveloped them. But it was evident that the velocity of the blast was not above that of an ordinary gale, and the dust it carried, though hot, was not incandescent.

At Lot 14 it was seen that many trees had their limbs twisted off and broken, and some of the negroes' houses had taken fire (probably mostly from hot falling bombs). The blast was more violent here, but not hot enough to set fire to the woodwork or char the green wood of the standing timber.

On the flat ground above the plantation buildings (at an elevation of about 1,000 feet), a further stage of devastation was encountered. The fields were here swept bare, the trees broken down, though not as a rule uprooted, their smaller branches swept away; a deep layer of black sand covered the crops of sugar cane. The blast was here a violent gale.

A little farther up the effects of the blast were remarkable. Enormous trees had been uprooted and cast down. Their leaves and finer branches, of course, had disappeared. In every case the fallen trunks pointed directly away from the crater. Even the great cotton trees, ten feet or more in diameter, were broken off or uprooted. The smaller trees had in a few cases been swept away like straws. The larger were merely cast down, and lay side by side, their tops directed down the valley, their roots toward the summit of the mountain. Most were charred, some deeply, but, as the wood was green, only the smaller branches had been consumed. The effect was like that produced by a violent hurricane, only more complete, for many of these trees had withstood the hurricane which ruined St. Vincent in 1898. At the lower limit of this region some curious effects of the hot sand blast could be seen. Where any branches or trunks were still standing they invariably showed themselves to be burnt and eroded on one side—that next the crater—the wood having been charred and the charred material removed by the action of a hot sand blast. On the side away from the crater the original bark was still left, unburnt, but dry and peeling off, that is, there had been

no erosion on the sheltered or lee side of the stems. The wood was too green to take fire, but the sand had been sufficiently hot to char the surfaces which were exposed to it.

Further up the hill, that is to say, above the 1,500-foot level, there was little left of the rich tropical vegetation which had covered it from summit to base. Blackened remains of tree trunks were to be seen, overturned or broken off near the ground, and buried in dark sand. The highest parts of the mountain are as bare and desolate a scene as could be imagined. The ash is five to twelve feet deep, and though full of large blocks and spongy bombs, is mostly so fine that when thoroughly wet it becomes a fine mud, very tenacious and slippery, in which one sinks to the knee. In it there is a good deal of burnt timber, utterly blackened and converted into charcoal. Everything has been mown down, and at the same time the intense heat has consumed all the smaller fragments and charred the larger. There is nothing to show what was the velocity of the blast when it left the crater. After a couple of miles it was that of a hurricane or tornado. The limit between the zone of uprooted trees and that of trees still standing, but broken and much damaged, is surprisingly sharp. At four miles from the crater the blast was traveling at twenty to forty miles an hour, and rapidly slowing down. This agrees with the evidence of an eyewitness who saw it when it reached the sea near Chateaubelair. It came over the water with a wave before it, but it did not overturn the small boats which lay in its course.

Another peculiar feature of this blast is the manner in which its course was modified by irregularities in the configuration of the ground over which it passed. To the north of the crater stands the encircling crater wall, already referred to as the Somma. There can be no doubt that a black cloud descended over this side of the mountain, though here the devastation is comparatively slight, and it is inferred that the high intervening ridge overlooking the crater served as a rampart and helped to protect the country behind it from the effects of the blast. The southern lip of the crater, on the other hand, is the lower, and the avalanche of hot sand seems to have poured over this lip almost like a fluid. Down the deep open valley between the Soufrière and the Morne Garu Mountain it rushed, ever following the steepest descent. It clung to the valley bottoms and coursed along them in a manner which somewhat recalls a raging torrent in a river. The streams in these valleys after descending the first part of the hill turn sharply at a right angle toward the coast, deflected by the opposing mass of the Morne Garu. The hot blast mostly followed these valleys, and in them it piled up enormous deposits of sand, but part of it swept up the shoulders of Morne Garu, and tore up the heavy timber which was growing there. The direction in which the fallen trunks point shows that the blast was split into two parts—one taking the east and one the west side of the mountain, rushing upward obliquely from below. The mountain protected the country behind, and the line of demarkation between the burnt and the green forest almost corresponds with the dividing ridge. The south side is green; the north side toward the Soufrière is devastated and burnt.

GEOLOGICAL MODIFICATIONS.

Apart from the changes which have taken place within the crater, and the deposits of ash which have formed in the river valleys, and on the surface of the hill, the only other important geological modification of the country has been the disappearance of a narrow strip of coast along the leeward side of the island. Near the mouth of the Wallibu and from thence northward to Morne Ronde, the sea has encroached on the land for perhaps two hundred yards. Below Wallibu plantation there stood a village of laborers' huts on a low flat beach with a bluff behind. Here the sea now washes the foot of a cliff some thirty feet high. This cliff consists of soft tuffs covered with several feet of new hot ashes, and is in an unstable condition, as masses are constantly falling down from its face. In this way a new beach is now forming in front of it. It is agreed by those who knew the district before the eruption that not only has the old beach disappeared, which carried the village and the public road, but that part of the bluff behind has also subsided. We were informed by Mr. T. M. McDonald, who is intimately acquainted with this coastline, that similar subsidences had also taken place, though on a much smaller scale, at several places farther north. There is no evidence elsewhere of any changes of level of land and sea. The tide marks on the rocks and the landing stages at the villages enabled us to ascertain that the level of high water was at any rate within a few inches of what it had been before. It was clear that the alterations in the coastline were due to local subsidence of the foreshores, and that they had mostly affected loose and ill-consolidated deposits, such as beach gravels and the fans of alluvium which had formed at the mouths of the streams. The submarine slopes on the leeward side of St. Vincent are very steep, averaging about one in four. Within half a mile of the shore the depth is often more than one hundred fathoms.

It seems most probable that owing to the concussions and earthquakes produced by the explosions, some of the less coherent accumulations on these steep slopes slipped bodily into the deep. On this supposition most of the facts would be explained, but at the same time it is possible that at Wallibu the inner margin of the depressed tract may be a fault line. It has a very straight trend, and it is a curious fact that this shore was formerly known as Hot Waters. This might indicate the existence of a fissure up which hot springs were rising.

COMPARISON OF THE SOUFRIÈRE WITH MONT PELÉE.

When we arrived at Martinique, we had the pleasure of meeting Prof. Lacroix, the head of the French Scientific Commission, which had spent some time in making a preliminary survey of Mont Pelée, and the north end of the island, and from him we obtained much valuable information regarding the sequence of events and the geological consequences of the eruptions in that quarter. It was our intention to make merely such reconnaissances as would enable us in a general way to ascertain the points of difference and of similarity between the outburst of Mont Pelée and that of the Soufrière, and to see what light the phenomena in Martinique threw on the events which had happened in St. Vincent.

Both volcanoes are of the same type, simple cones with a large vent near the summit and without parasitic craters. They are both deeply scored with ravines, and on their southwest sides there is a broad valley—occupied at Martinique by St. Pierre City, at St. Vincent by the Wallibu. It is in these valleys that the destruction has been most pronounced. In both the recent eruptions have been characterized by paroxysmal discharges of incandescent ashes, and a complete absence of lava streams.

In St. Vincent, however, the mass of material ejected has been much greater, and a considerably larger area of country has been devastated than in Martinique. That the loss of life was not so large can be accounted for by the absence of a populous city at the foot of the mountain. Had the city of St. Pierre been planted at the mouth of the Wallibu, there can be no doubt it would have been equally completely destroyed.

On Mont Pelée we understand that a fissure has opened on the south side of the mountain between the summit and St. Pierre, from which the blast was emitted which overwhelmed the city. But on the Soufrière the old orifices have been made use of. The eruption of Pelée began with the flow of mud lavas, but none such were seen in St. Vincent. On the other hand, the hot blast which swept down on the doomed city was essentially similar to that which we have described as having taken place at the Soufrière. Both eruptions produced principally hot sand and dust, with a small proportion of bombs and ejected blocks.

OBSERVATIONS OF AN ERUPTION OF MONT PELÉE.

We were fortunate in having an opportunity to witness one of the more important eruptions of Mont Pelée before we left Martinique, and this enabled us to see how far the actual phenomena corresponded with the ideas we had been led to form from an inspection of the effects of the earlier outbursts. On July 9 we were in a small sloop of ten tons, the "Minerva," of Grenada, which we had hired to act as a convenient base for our expeditions on the mountain. The morning was spent in St. Pierre City, and on the sugar cane plantations on the lower slopes of the mountain on the banks of the Rivière des Pères. The volcano was beautifully clear. Every ravine and furrow, every ridge and crag, on its gaunt naked surface stood out clearly in the sunlight. Thin clouds veiled the summit, but now and then the mist would lift sufficiently to show us the jagged, broken cliff which overlooks the cleft. From the triangular fissure which serves as the crater hardly a whiff of steam was seen to rise, and the great heap of hot bowlders which lies on the north side of and above this fissure could be perfectly made out. Small landslides took place in it occasionally, and small jets of steam rose now and again from between the stones.

A little after midday large steam clouds began to rise, one every ten or twenty minutes, with a low rumble. As they rose they expanded, becoming club-shaped and consisting of many globular rolling masses, constantly increasing in number and in size as they ascended in the air. They might be compared to a bunch of grapes, large and small, or to a gigantic cauliflower. When their upward velocity diminished they floated away to leeward, and fine ash rained down in a dense mist as they drifted over the western side of the mountain. They occasioned no anxiety in our minds, as we had found that the mountain was never long without exhibiting these discharges, and they were due merely to an escape of steam carrying with it fine dust. They rose, as a rule, to heights of 5,000 or 6,000 feet above the sea.

That afternoon as the sun was getting lower in the heavens and the details of ravine and spur showed a contrast of light and shadow which was absent at midday, we sailed along from St. Pierre to Précheur, intending to obtain a series of general photographs of the hill. The steam puffs continued, and, about 6 o'clock, as we were standing back across the bay of St. Pierre, they became more numerous, though not much larger in size. We ran down to Carbet, a village one and a half miles south of St. Pierre, where there is a supply of excellent water and good anchorage. About half-past six it was obvious that the activity of the mountain was increasing. The cauliflower clouds were no longer distinct and separate, each following the other after an interval, but arose in such rapid succession that they were blended in a continuous emission. A thick cloud of steam streamed away before the wind so laden with dust that all the leeward side of the hill and the sea for six miles from the shore was covered with a dense pall of fine falling ash. The sun setting behind this cloud lost all its brightness and became a pale yellowish-green disk, easily observable with the naked eye. Darkness followed the short twilight of the tropics, but a four days' old moon shed sufficient light to enable us to see what was happening on the hillside.

AN INCANDESCENT AVALANCHE.

Just before darkness closed in we noticed a cloud which had in it something peculiar, hanging over the lip of the fissure. At first glance it resembled the globular cauliflower masses of steam. It was, however, darker in color, and did not ascend in the air or float away, but retained its shape and slowly got larger and larger. After observing it for a short time we concluded that it was traveling straight down the hill toward us, expanding somewhat as it came, but not rising in the air, only rolling over the surface of the ground. It was so totally distinct in its behavior from the ascending steam clouds that our attention was riveted on it, and we were not without apprehension as to its character. It seemed to take some time to reach the sea (several minutes at least), and as it rolled over the bay we could see that through it there played innumerable lightnings. We weighed anchor and hoisted the sails, and in a few minutes were slipping southward along the coast with a slight easterly wind and a favorable tide. We had, however, scarcely got under way when it became clear that an eruption was impending. As the darkness deepened a dull red reflection was seen in the trade-wind cloud which covered the mountain summit. This became brighter and brighter, and soon we saw red-hot stones projected from the crater, bowling down the mountain slopes and giving off glowing sparks. Suddenly the whole cloud was brightly illuminated, and the sailors cried, "The mountain bursts!" In an incredibly short space of time a red-hot avalanche swept down to the sea. We could not see it start from the crater owing to the intervening veil of cloud, but the lower parts of the mountain were clear, and the glowing cataract poured over them right down to the shores of the bay. It was dull red, with a billowy surface, reminding one of a snow avalanche. In it there were larger stones which stood out as streaks of bright red, tumbling down and emitting showers of sparks. In a few seconds it was over. A loud angry growl had burst from the mountain at the moment when this avalanche was launched from the crater. It is difficult to say how long an interval elapsed between the time when the great glare burst on the summit and the incandescent avalanche reached the sea. Possibly it occupied a couple of minutes; it could hardly have been more. Undoubtedly the velocity was terrific. Had any buildings stood in its path they would have been utterly wiped out, and no living creature could have survived that blast.

THE LIGHTNING DISCHARGES.

Hardly had its red light faded when a rounded black cloud began to shape itself against the starlit sky, exactly where the avalanche had been. The pale moonlight shining on it showed us that it was globular, with a bulging surface, covered with rounded protuberant masses, which swelled and multiplied with a terrible energy. It rushed forward over the waters, directly toward us, boiling and changing its form every instant. In its face there sparkled innumerable lightnings, short, and many of them horizontal. Especially at its base there was a continuous scintillation. The cloud itself was black as night, dense and solid, and the flickering lightnings gave it an indescribably venomous appearance. It moved with great velocity, and as it approached it got larger and larger, but retained its rounded form. It did not spread out laterally, neither did it rise into the air, but swept on over the sea in surging globular masses, coruscating with lightnings. When about a mile from us it was perceptibly slowing down. We then estimated that it was two miles broad and about one mile high. It began to change its form; fresh protuberances ceased to shoot out or grew but slowly. They were less globular, and the face of the cloud more nearly resembled a black curtain draped in folds. At the same time it became paler and more gray in color, and for a time the surface shimmered in the moonlight like a piece of silk. The particles of ash were now settling down, and the white steam, freed from entangled dust, was beginning to rise in the air.

The cloud still traveled forward, but now was mostly steam, and rose from the surface of the sea, passing over our heads in a great tongue-shaped mass, which in a few minutes was directly above us. Then stones, some as large as a chestnut, began to fall on the boat. They were followed by small pellets, which rattled on the deck like a shower of peas. In a minute or two fine gray ash, moist and clinging together in small globules, poured down upon us. After that for some time there was a rain of dry gray ashes. But the cloud had lost most of its solid matter, and as it shot forward over our heads it left us in a stratum of clear pure air. When the fine ash began to fall there was a smell of sulphurous acid, but not very marked. There was no rain.

The volume of steam discharged must have been enormous, for the tongue-shaped cloud broadening as it passed southward covered the whole sky except a thin rim on the extreme horizon. Dust fell on Fort de France and the whole south end of Martinique. The display of lightning was magnificent. It threaded the cloud in every direction in irregular branching lines. At the same time there was a continuous low rumble overhead.

What happened on Mont Pelée after this discharge cannot be definitely ascertained. For some hours afterward there were brilliant lightnings and loud noises which we took for thunder. That night there was a heavy thunderstorm over the north end of Martinique, and much of the lightning was atmospheric, but probably the eruption had something to do with it, and the noises may have been in part of volcanic origin.

CHARACTERISTICS OF THE ERUPTIONS.

There can be no doubt that the eruption we witnessed was a counterpart of that which destroyed St. Pierre. The mechanism of these discharges is obscure, and many interesting problems are involved. But we are convinced that the glowing avalanche consisted of hot sand and gases—principally steam; and when we passed the hill in R.M.S. "Wear" a few days later, we had, by the kindness of the captain, an excellent opportunity of making a close examination of the shore from the bridge of the steamboat. The southwest side of the hill along the course of the Rivière Seche was covered with a thin coating of freshly fallen fine gray ashes, which appeared to be thickest in the stream valleys. The water of the rivers flowing down this part of the hill was steaming hot. This was undoubtedly the material emitted from the crater on the night of the eruption. There was no lava. We saw no explosions of combustible gases, and nothing like a sheet of flame. We were agreed that the scintillations in the cloud were ordinary lightnings which shot from one part of its mass to another, and partly also struck the sea beneath.

The most peculiar feature of these eruptions is the avalanche of incandescent sand and the great black cloud which accompanies it. The preliminary stages of the eruption, which may occupy a few days or only a few hours, consist of outbursts of steam, fine dust and stones, and the discharge of the crater lakes as torrents of water or of mud. In them there is nothing unusual, but as soon as the throat of the crater is thoroughly cleared, and the climax of the eruption is reached, a mass of incandescent lava rises and wells over the lip of the crater in the form of an avalanche of red-hot dust. It is a lava blown to pieces by the expansion of the gases it contains. It rushes

down the slopes of the hill, carrying with it a terrific blast, which mows down everything in its path. The mixture of dust and gas behaves in many ways like a fluid. The exact chemical composition of these gases remains unsettled. They apparently consist principally of steam and sulphurous acid. There are many reasons which made it unlikely that they contain much oxygen, and they do not support respiration.

A CHART OF THE HUMAN HAIR STREAMS, SHOWING THEIR LINEAGE AND HISTORY.*

By WALTER KIDD, M.D., F.Z.S.

THE interrogation of Nature is the richest seed-plot of science, and those who cultivate it are rewarded in due time if only their foundations be "well and truly laid." Whatever the answers may be, they will never be other than true, and we must needs abide by the result of our interrogation. No oracles are delivered by Nature's voice, rather does she teach by the Socratic method of questioning her learners. Thus it is that, since the genius of Hutton opened up the way into the new world of geology, there are geological problems staring us in the face as we pursue our way on this planet, some inviting or compelling inquiry, some suggesting complicated and, perhaps, hopeless study. It is not less so with biology, which a greater than Hutton has illuminated, and where still the unknown but knowable meets the naturalist on every hand.

To the simpler class of problems belong those facts of the direction of hair on the human body, open to the study of most of us on our own persons or on that of any young hairy subject. Those who have not looked particularly into the matter are not aware that, in addition to the well-known hairy regions, every inch of the human skin is clad with fine hairs, except the palms of the hands, soles of the feet, third phalanges of the fingers and toes, and one or two other small areas. The character of this growth varies from a covering of hairs, so minute that a good lens is needed for their detection, to a profusion of long hair of a Simian character, reaching its maximum in the Ainu or hairy aborigines of Japan.

It is agreed to look upon this hairy covering as a vestige of one which was of use to man's hairy, arboreal, ape-like ancestors, and to consider it as in process of disappearance. Whatever view we may take of its value, it cannot but be subject to natural laws, and the canons of investigation applied to other facts of Nature must be applied in this small instance also.

The rate of growth of the human hair, on the head at least, is an inch in two months, and it is probably less on the general surface of the body.

The hairs are inserted in the skin at an acute angle on every part of the body except the eyelids, where they are at right angles to the surface, and wherever they are found the hair-tracts have a constant direction for that region. This sloping direction of hair is common to nearly all lower animals, the mole being the most marked exception, and the question cannot but suggest itself: Is this slope adapted to the needs of the animal or man, or is it adapted by their habits? This debatable point cannot be dealt with here.

It is proposed here to study the direction of the human hair streams and the causation of their various peculiarities. Broadly speaking these streams, according to their range, show two things about man; First, what he has been; secondly, what he has done; or, in other words, his ancestry and his habits of life.

The point which strikes one first in examining the chart of these hair streams is the very complicated direction taken by them on the head, neck and trunk, and on the upper extremity, and the equally marked simplicity of the direction of those on the lower extremity. Certain of the former literally demand inquiry as to their cause, on the sound principle that every phenomenon in Nature is to be looked upon as capable of explanation, whether by the light of present knowledge, or by future methods of discovery. It is not necessary to employ hypothesis at all extravagantly or to wait indefinitely for further light in explaining most of these peculiarities in question. They may be open to explanation by one of three hypotheses:

1. They may have been created with the rest of man's physical frame, as an adaptation to his habits or certain of his needs. This view will hardly commend itself in the light of present knowledge. Apart from other reasons, the direction in which the human hair slopes in the greater part of his body is immaterial to his comfort or well-being.

2. Adaptation and natural selection in the struggle for life might help us. Here, again, the question of utility is involved if such views are to be maintained. It is strange to find such a statement as the following in an important work for students on physiology by Mr. Leonard Hill, who says without any reserve: "The fine hairs on the body and limbs of man are arranged, as in the monkey, to point in certain directions so as to shoot off the rain from the body when climbing."*

This statement is not only contrary to reason but to the facts of the case, as may be seen at once on reference to the figures, e. g., at the back of the neck, the front of the neck, the chest, the back of the trunk and the outer surface of the arm as far as the middle. These few regions alone are enough to disprove Mr. Leonard Hill's statement.

In considering man's present covering of hair it is not necessary to prove that, except in one or two exposed regions where sexual selection may operate, selectionist views as to the cause of the peculiarities in question cannot hold. If it could be shown that they were survivals of hair slope useful to Simian ancestors the case would be different, but a glance at the figures shows this not to be the case, and some other cause for them must be sought.

3. They may have been modified from a simple type of hair slope through use-inheritance, and this is the view held here.

According to the received view of man's physical descent his prototype must have been Simian in form, partially assuming the erect posture, and perhaps combining some of the characteristics of each of the four genera of existing anthropoid apes.

It follows then that he possessed a hairy covering little differing from that of a gibbon or a chimpanzee. In other words, the primitive stock of man showed a simple and very slightly differentiated covering of hair, whose direction was, broadly speaking, from the cephalic to the caudal end of his trunk, from the proximal to the distal end of his limbs, and on his head the hair streams either parted in the center like those of a chimpanzee, or passed backward from the projecting eyebrows over the low frontal and parietal regions, and fell down his neck in a vertical direction. An hypothetical diagram of this hairy covering may be constructed, and is shown in Figs. *A, B*. If this representation of the primitive hair slope of man's early ancestors be not allowed there is an end to the validity of comparative anatomy, and the findings of that great science are set aside in this instance as not agreeing with certain other tenets. But I may safely take it that the direction of hair indicated in Figs. *A, B*, cannot be challenged except in some entirely unimportant details. There is an illustration in "Living Races of Man," part iv., p. 110, which is most suggestive on this point, the dorsal surface of the body of a girl two years old being figured and showing a very primitive covering of thick long hair arranged exactly as the hair of a gibbon is arranged, and this would seem to be a reversion to type and a latter-day illustration of the manner in which man's hairy prototype had his hairy covering disposed. The contrast in this illustration between the hair slope of the case in point and that of man, as we know him, is very striking.

The main tracts of hair on the body of man are represented on the accompanying diagrams and indicated in outline by arrows which point in the direction assumed by the hair stream of the parts covered by these arrows. Any verbal description of these would be superfluous, and it is only necessary to point out that the diagrams illustrate the normal directions of man's hairy covering, and that these are remarkably constant, whether in the fœtus, as described in 1839 by Eschricht, and 1857 by C. A. Voigt, or in newly-born infants that I have examined, or in hairy young adults, and even in older subjects whose hair has not been worn off by friction. The only difference between the direction of hair in an infant and an adult is that the specially human peculiarities are more pronounced in an adult.

These hair streams may be classified, bearing in mind the direction of hair of man's early ancestors, and its altered direction at the present day, into:

1. Primitive, derived from ape-like ancestors, marked by arrows with single heads;
2. Acquired (A) By morphological change marked by arrows with two heads;
(B) By habit or use, marked by arrows with three heads.

The division of man's hair into separate streams is, of course, an artificial one, but is justified by a reference to the diagrams, which show that the arrows merely indicate the main direction in which a certain tract of hair separates itself from surrounding tracts.

Two considerations must be always kept in mind in studying man's hair slope: First, that it must be looked upon as a stream; secondly, that in accordance with analogy, it moves in the lines of least resistance. As the hairs are set at an acute angle and the rate of growth is about an inch in two months, and as the growth consists in the shaft being pushed out of the hair follicle by changes there, until its normal length is attained, when the end wears off, there are present just those mechanical conditions needed to produce a slowly moving stream passing in the lines of least resistance. The best illustration of this process afforded by nature is a glacier, though the forces in operation are of a different kind, and I would suggest that the direction taken by the hair of man in many regions of his body is governed as much by purely mechanical laws as the windings of a glacier, and is equally far removed from the province of adaptation to needs and selection.

On the head the chief peculiarities are correlated with morphological change, except at the edge of the scalp, where varying methods of dressing the hair have availed to produce a remarkable series of peculiarities found even in infants, which cannot be here detailed.* Two are shown in Figs. *E, F*.

The face presents certain changes from Simian type probably due to sexual selection.

The external ears conform rather closely to a Simian arrangement.

The neck presents in front a remarkable reverse of slope at the level of the larynx (Fig. *C*), which can only be due to some special human habit or use. It occurs closely at the spot where any clothing worn round the neck terminates, and as may be seen in the neck of a man with a beard not too long, the influence of clothing does tend to draw the lower portions of the neck streams upward.

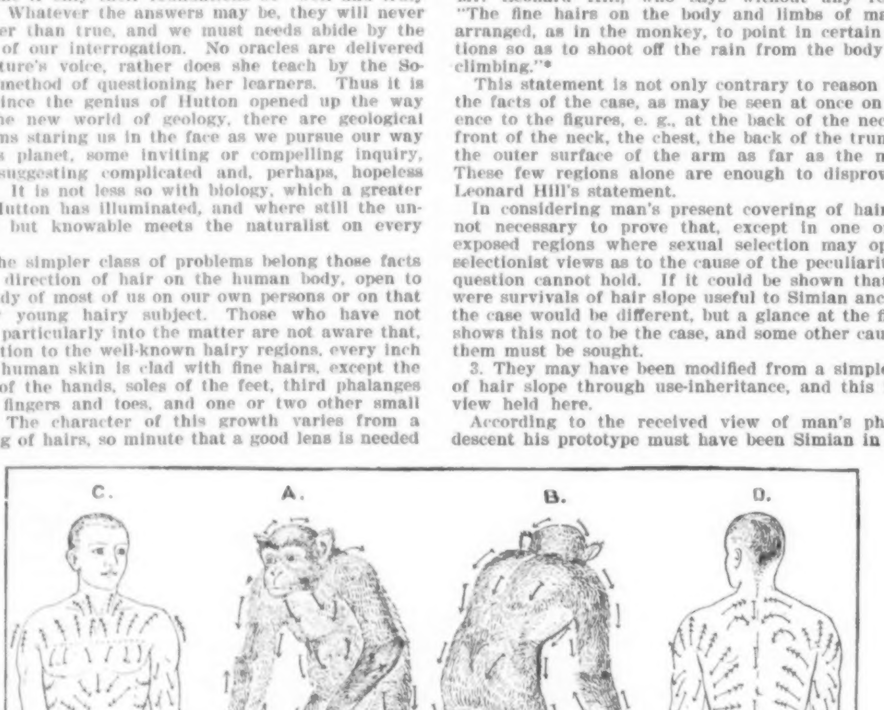
At the back of the neck two well-marked arrangements (Figs. *G, H*) are to be noted, and these occur about equally frequently in this country in any given number of persons. It would appear that no other cause than varying methods of dressing the hair in this "critical area" of the hair streams can have produced such entirely non-Simian changes.†

On the chest in front a remarkable arrangement is shown in the Fig. *C*. The point of departure upward of the streams which go to form those of the neck is found with singular uniformity at the level of the second costal cartilage or second intercostal space. It is said in Lydekker's "Royal Natural History" that something of this arrangement is found in the gorilla. It is otherwise in the young specimen at South Kensington, and not visible in the other three adult specimens. In producing this human peculiarity clothing is probably the efficient cause. It is easy to see that in respiration, which involves much movement of the upper ribs, a force is acting in inspiration and absent when the chest falls in expiration, calculated to draw the growing stream of hair in this, the line of least resistance. Here is an adequate cause acting during two-thirds of man's life, i. e., during daytime, when the effects of pressure against clothing would come into play.

On the lower part of the chest and the front of the abdomen such changes as are found are probably due only to morphological change.

The side of the abdomen shows the singular parting line, figured (Fig. *C*) as extending from the axilla to the level of the umbilicus, here sometimes terminating in a whorl and, in most cases, extending to the groin. This wholly human peculiarity is most probably accounted for by the fact that in sleep on one or other side, which is the greatly predominant attitude, the arm lies along this parting and determines the separation of the abdominal and dorsal streams in accordance with the principle that these flow in the lines of least resistance.

On the back the direction of hair in man and his prototype are markedly contrasted. The upward slope shown exactly corresponds to the direction which would be induced by the normal attitude of man in sleep, viz., on one or other side and with the head, and perhaps the shoulder, raised on a pillow. Here, again, as there is a force calculated to produce what we find existing for about a third of a human being's life, it is unnecessary, according to "the law of parsimony," to go beyond such an explanation. The equally strange slope of hair which is seen at the back of the arm pit is also directed in a way which this force referred to would produce. In addition to the mechanics of the position during sleep, the mechanical effect of sitting with the back leaning against any support emphasizes the existing direction on the shoulders and upper part of the back. Our Troglodyte ancestors cannot well have been luxurious persons, but even they must have had many hours of their strenuous lives free enough to lean against the trunk of a tree, the side of a cave, or some bank of earth, and when we come to the case of



Two views (A and B) of the assumed prototype of Man, showing the primitive direction of hair. Seven views (C, D, E, F, G, H, I) of Man's body.—Primitive tracts of hair shown by arrows with single heads; those acquired by morphological changes marked by arrows with two heads. Those acquired by use and habit marked by arrows with three heads.

* Knowledge.

* See "Manual of Physiology," p. 324.

* See Proceedings of Anatomical Society of Great Britain and Ireland, 1902.

† See "Journal of Anatomy and Physiology," Vol. XXXV., pp. 311, 312, 313; and "Use-Inheritance." Walter Kidd. (A. & C. Black, 1901.) Pp. 39, 40.

modern man, the opportunities for such indulgence have been obviously much increased.

On the upper extremity the complicated slope of hair strikes one on looking at Figs. *C*, *D*. On the upper half and outer side the singular upward direction which begins at the insertion of the deltoid is clearly of the same nature and due to the same causation as the peculiarities on the back. The lower half and most of the forearm are equally Simian and simple. The only exception on the forearm is the reversed slope on the extensor surface, due, I submit, to the resultant of two forces, a downward and forward one, acting when this part of the limb rests on any object, as it frequently does. This point does not distinguish man much from apes and monkeys, and in all of these groups similar mechanical forces operate to produce it, including in the latter the effect of tropical rain, in their arboreal lives. I have referred at much more length to the causation of this hair slope elsewhere,* and need only say here that it is more probable that adaptation by habits and use is a far more intelligible cause for it than any adaptation to the needs of the animal on which selection might act. This peculiarity is found very marked in carnivores, such as a short-haired dog, and ungulates such as certain antelopes, which lie with their fore limbs planted in front of them, in the very attitude calculated to produce this slope.

On the lower extremity the direction of hairs is as simple and primitive as that on the upper is complicated and acquired. The only area worth noting is the upper third of the back of the thigh, where the effect of the sitting attitude is clearly able to produce the direction indicated. On the rest of this limb so few forces act on the skin surface with any uniformity that it has retained its primitive slope of hair.

It is worth noting that the theory of use-inheritance carries with it the view that the effects of disuse are inherited, and this is remarkably illustrated by the way in which in a very hairy subject, the growth of hair on the leg ceases sharply at a point opposite to the ankle joint. It is difficult to see how any other influence than that of the friction of a shoe or low boot can produce this sudden transition from a hairy leg to a nearly hairless foot. The contrast also in a very hairy man between the great amount of hair on the back of the hand and the appearance of scattered long hairs on the instep of the same subject is most suggestive.

In addition to any interest possessed by these facts they have a bearing on heredity. The inference to be drawn from them seems to be that acquired characters may be, and in this case are, inherited. If the descent of man be what it is claimed to be, he has somehow acquired and transmitted a very remarkable series of changes of hair direction. It would seem that these can only have arisen through habit, use and the action of environments, and by disuse, and that any reference of them to selection is estopped. There is no hair tract of the human body diverging from the ancestral type of slope which has not an adequate and ascertainable mechanical force to which the facts may fairly be attributed.

[The illustrative plate has been prepared under my direction by Mr. R. E. Holding, who has greatly assisted my demonstration of the subject.]

DEATH OF PROF. VIRCHOW.†

PROF. RUDOLF VIRCHOW died in Berlin on September 5, aged nearly eighty-one years. One of the greatest medical discoverers of this or any other age, he spent nearly sixty years in adding to the sum of human knowledge. When, on the occasion of his eightieth birthday, statesmen and medical men of all the world united to give him an unparalleled ovation, and Prof. Virchow made a speech of two hours, tracing the development of pathological science, it was necessary for him to recount to a great extent his own achievements. "The history of Prof. Virchow's life and work," declared the London Times, in this connection, "forms one of the grandest illustrations of the triumph achieved over every obstacle by genius manifested in infinite labor, and guided by absolute love of truth and dauntless courage."

The history of Prof. Virchow's life, from his birth, in 1821, as the son of a small shopkeeper and farmer in the village of Schivelbein, in Pomerania, has frequently been narrated. Till the age of thirteen, he was educated at the Volkschule of his native village; at seventeen he passed his "departing examination" at the Gymnasium of Köslin, and immediately afterward proceeded to Berlin to study medicine. He graduated as doctor in 1843, and became assistant professor at the Berlin Charity Hospital. In the spring of 1848 he was the junior member of a government commission sent to investigate an epidemic of typhus caused by famine among the hand-loom weavers of the Silesian highlands, and the result of his studies, which he embodied in a brilliant and forceful report, gave a permanent direction both to his scientific and to his political career.

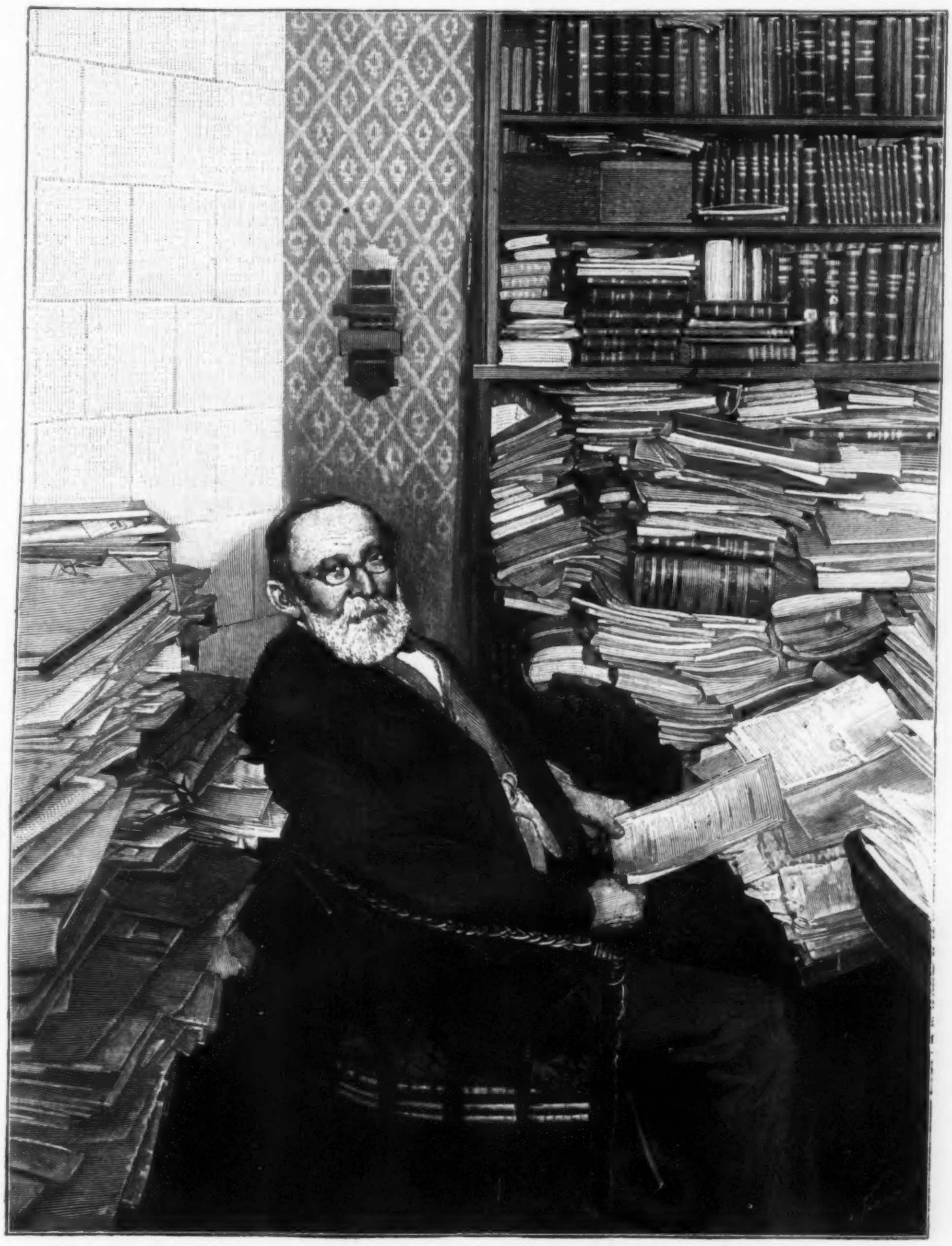
Before undertaking this task, he had been appointed, in 1847, a regular lecturer in the University of Berlin, and in the same year had founded, together with Dr. Reinhardt, his invaluable Archives of Pathological Anatomy and Physiology and of Clinical Medicine, which have been published ever since. His radical views during the stirring revolutionary times of 1848-49 led to his expulsion from his Berlin chair. Accepting a call from the University of Würzburg, he did there some of the most remarkable work of his life, and with a coterie of brilliant fellow-teachers soon raised the little university into the front rank of medical schools. In 1856 the University of Berlin recalled him to a full professorship, and, despite his intense interest in politics, he carried on his studies and his teachings without cessation from that time until within six months of his death. His greatest discovery was made at Würzburg, where he first laid down the theory of the cellular nature of animal tissue, and it was his book, entitled "Cellular Pathology," which not only established his reputation throughout Germany, but made his name respected and honored throughout the entire world. Taking the place of the former vague views of vitality, this theory formed the basis for a new science of physiology.

After this great achievement, Prof. Virchow made one discovery after another. Never a practitioner himself, he was eminently a teacher of physicians. To these, in later years, the rise and development of bacteriology seemed at first to be in conflict with Virchow's cellular system. The entire medical profession now understands that, while bacteria may cause disease, the disease itself is a particular state of the cells of which the human organism is composed.

But the range of his investigations and discoveries was never confined to any one line or field. Our knowledge of tumors, of tuberculosis, of diphtheria, of embolism, and of the brain, is very largely what Virchow has made it. Indeed, a medical authority has recently declared that "if we should expunge all that medicine as a science directly and indirectly owes to him, comparatively little would be left." "With him," it continues, "begins the scientific era in the healing art, and it is he who has made us the coequals and the copartners of all strivers in the realm of science." Between 1848 and 1879, he wrote voluminously on subjects connected with public hygiene, the reform of medicine, epidemics and endemics, statistics of morbidity and mortality, hospitals, military medicine, school hygiene, criminal law, forensic medicine, and the cleaning of cities. At the same time he kept on publishing his writings on special subjects, such as "Inflammation of Blood Vessels," "Contributions to the Pathology of the Skull and Brain," "Cranial Deformities," "New Formation of Gray Cerebral Substance," "Cretinism," etc., etc. In the use of his special knife, which he named "the Pathologist's Sword," in the operating room, he displayed an accuracy and skill that were the wonder of beholders.

But, aside from the field of medicine, this great man displayed a versatility that gave point to the popular saying about him in Berlin, that "when he died it would be found that he was not one man but four men." He rapidly made himself, while still young, an authority in ethnology, a pioneer in anthropology, an able archæologist, and a leading Egyptologist. He established the measurements for comparative anthropology, and collected race data as no other man had ever done. The discoveries at Troy were due as much to his knowledge and encouragement as to Schliemann himself, whose stanch friend and invariable defender Virchow was. With Schliemann he traveled through Nubia, Egypt, and the Peloponnesus. In 1879 he took part in Schliemenn's excavations in Hissarlik. The graves of Koban he described in 1883, and similarly valuable works in archæology appeared in 1880 and 1882. He was for years one of the teachers of the Berlin Association of Artisans, and devoted no little of his precious time to the spreading of the knowledge of nature among the poor. As a linguist, Virchow was a marvel to scientific men. At nearly all international conferences he was able to address the great audiences that came to hear him in their own languages. During the wars with Austria and France he was an officer of the army aid societies in Berlin, and conducted the first sanitary trains into the enemies' territory.

Such an extraordinary record of achievement would seem to have been all that was possible for one man even in four-score years of intense scientific application. Not so with Virchow. In the midst of his manifold scientific researches he found time to interest himself deeply in public affairs. The failure of the liberal movement of 1848 and 1849 did not lead him to abandon his country. In 1859 he became a City Councilor of Berlin, a position which he held and never neglected for more than forty-two years. He was elected to the Prussian Chamber as one of the Freisinnig or Radical party in 1862, and served in that body continuously until his death. In this Chamber he was for twenty-five years chairman of the Committee on Finance, and to a very great extent he himself laid the foundation of the present constitutional budget system of Prussia, just as he is also responsible for the German laws in relation to fishing, which he drew up or inspired when at the head of the German Fishing Association. From 1880 to 1893 he was, in addition to his other activities, a member of the Reichstag, in which he represented a Berlin constituency until ousted by the Social-Democrats—a characteristically stupid performance, in view of the enormous benefits which Prof. Virchow had conferred upon mankind in general and his countrymen in particular, and in view of his liberal political opinions. It was chiefly owing to him that Berlin has become one of the healthiest cities in the world. Under his direction an ample supply of pure water was obtained, while his advocacy secured for the city a model system of sewage and sewage farms. Nearly every hospital in Berlin bears traces of his initiative or other influence, while several of the great museums dedicated to the education of



PROF. RUDOLF VIRCHOW IN HIS STUDY.

* Proc. Zoological Society, London, June, 1900, pp. 676-77; "Journal of Anatomy and Physiology," Vol. XXXV., p. 319; "Use-Inheritance," pp. 28-33.

† New York Evening Post.

the public were either entirely created or greatly enlarged by him, notably the Ethnological and Pathological Museums. But if the Social Democrats were blind to these things and to the enormous advantages resulting from his being in the Reichstag, Berlin has again and again marked its sense of its overwhelming and everlasting obligation to him, as by giving his name to the enormous new hospital now nearing completion.

Prof. Virchow was a most valuable legislator. While not an orator, he was an able and effective speaker, who never failed to grasp the situation under discussion in all its bearings. On his feet Virchow was exceedingly calm and deliberate, and was never carried away by passion, and his spoken sentences, scarcely distinguishable from his written ones, are clear, forcible, logical, and convincing. None held the privileges of the representatives of the people so dear as this man of genius. Nothing which came before the Chamber or Reichstag was of too slight importance to merit his interest. He was always listened to with the deepest attention, particularly when he spoke on the "Kulturkampf," a name invented by him which has become part of the language, and is now the only term used to describe the contest between religion and the state.

With Bismarck, a man of Virchow's liberal views was naturally at sword's points, and few, if any, of his opponents worried the great chancellor as much as this indomitable and magnificently courageous scientist. So bitter, indeed, became their differences that Bismarck challenged him to a duel. A combat was, however, prevented by the intercession of friends, but the controversies between the two form some of the most interesting passages in Bismarck's life, and are given very considerable space in the biographies of the Chancellor. In 1877 Virchow paid for his radicalism by being deprived of the rectorate of the University of Berlin, in which he was, however, triumphantly reinstated in 1892. Naturally this punishment, for which Bismarck was largely responsible, was as little able to affect Virchow's views and the vigor of his language as had been his removal from his lectureship at the beginning of his great career.

In person Virchow was of less than the average stature and of very winning and attractive manners. "His expression," said one of his students recently, "is that of extraordinary courage; his attention once drawn to you, you feel as if he were fixing you in focus on the object glass of his mental microscope." But there was nothing unfriendly in this gaze. Indeed, his manner frequently deserved the adjective charming, particularly at the dinner table and on social occasions, and few great men have been distinguished by like modesty and unselfishness. His worldwide travels gave him additional breadth of mind, and a recognition of the aspirations and achievements of other nations which was quite free from any narrow bias of nationality. When he went to England in 1898 to lecture before the Royal Society of Medicine, his speech was most generously appreciative of the labors and achievements of English scientific men. Indeed, he may be said to have taught the English to value the forgotten name of Glisson, while in Italy he informed the Italians of their debt to Margagni. For America and American aspirations he always showed great interest, understanding, and appreciation, although he never visited this country.

The celebrations of his seventieth and eightieth birthdays were marked events in the history of science. Even royalty was constrained to recognize the intellectual eminence of this unconquerable political freethinker. Few men, if any, have ever enjoyed such international acclaim as came to this intellectual giant and king of science on those occasions, and to few men has it been given to do so much to uplift their fellowmen and to add so much to the sum total of human knowledge. "We now offer our salutations to Claude Bernard on his entrance into immortality," said Gambetta when the hand of death had put an end to all possibility of envy. Such heartfelt salutations as came to Virchow living have come to few men since human deeds have been recorded, and perhaps none have been so spontaneous, so warm, so genuine, so free from any trace of hate or envy, and so worldwide. Virchow's entrance into immortality can be accomplished by no greater and no more precious tributes to the man or to the intellect than have already been paid to him.

THE RELATION OF THE PSYCHIC LIFE TO THE NERVOUS SYSTEM.*

As Ernst du Mach (one of the most suggestive of modern writers along this line: a physicist, yet one who has brought to the problems of psychology a breadth of view that very few men have manifested) says: "Sensations are the elements of the world." So they are: if you analyze it you never get beyond your sensations; they are the elements out of which all psychical phenomena are built. There are certain cases which seem at first thought to contradict this position; for example, that of Laura Bridgman, the deaf-blind mute, or Helen Keller, neither of whom had the sense of sight or hearing and yet have or did achieve very considerable success in intellectual lines. Nevertheless, such cases as these only serve to point out and emphasize the truth which I have mentioned, because they had to be approached in all other directions through the senses which did remain to them; so that rather than being a case in which this rule is not supported it lends additional strength to the view that all knowledge of the world, of ourselves, of each other—all knowledge whatsoever—is ultimately derivable from the sensations; in short, if we could wall up our minds—our brain—completely, if an infant were to lose not only sight and hearing, but touch, taste and smell as well, then there would remain to it no opportunities according to this view for gaining any kind of knowledge.

We cannot directly know stimuli, nor what is back of them; we can only know their effects. There is very good reason to believe that there are as many physico-chemical processes as there are different sensations with regard to light, that is, this view of color sensation would hold, not that there are certain nerve cells that have for their purpose the function of registering red and others of registering blue; but that red and blue, each of them, excite certain chemical and physical changes in the retina, and that these changes are different in the two colors and, consequently, the sensations are different ones in the two cases; that is, there are as many physico-chemical processes as there are distinguishable sensations. In animals other than ourselves we can only know sensation by inference, which we draw from their acts or movements; it is true of ourselves among the various members of the human race and it is doubly true of lower animals. We can only infer that they are sensitive by the way in which they behave, and this way is usually by some movement, so that when an animal is stimulated and there results a corresponding movement, if we are pretty sure that consciousness has not entered into that we say "there is a reflex." Sensations, then, are only the sensory side of what on the other side is a motor reflex, and the two together make up a reflex act.

There has been a good deal of discussion with regard to what position in psychological research instincts hold. The instincts are merely complex and general reflexes, that is, if you call that a reflex act when you put a bit of acid on a frog's back (the frog having been previously decapitated so that the brain has no influence whatever) and the frog reaches up and scratches its back, there are a great many such reflexes—a great many things which are instinctive. For example, take some of our own inherited reflexes about which there can be no doubt; there is no question whatever that there is a reflex act in the sucking or the crying of a human infant. Yet they are instinctive acts; they involve perception, and inherited instinct; and they involve such a complex form of reflexes—so many sensory nerves, motor nerves, and muscles—that we speak of the whole thing not as a reflex or a simple reflex but an instinct.

This is evident enough in the case of most instincts. Of course there are some extremely complex ones where it is not so easily seen; but it seems to me highly probable that instincts in general are only complex, highly co-ordinated reflexes, and that consciousness does not enter into them at all, or at least to a very limited extent. Qualifying this there comes an instinct to the bird in the spring to migrate to the north and again in the fall to the south; the tendency which drives or starts the bird—keeps it migrating—is an inherited instinct; it would have carried it out if it had not seen other birds take it; but the path which it follows—the fact that it goes annually up and down the Delaware, and not the Susquehanna Valley—that the same bird will follow its peculiar path is probably due to its memory—to the fact that it has an eye for landmarks, that it sees and remembers them; and it is very probable that the same thing is true of shad and salmon. Shad hatched in the upper Delaware come back to the Delaware; those hatched in the Susquehanna come back through the Chesapeake into the Susquehanna; and the like is true of salmon. It is highly probable that while these fish migrate through an instinct, they have associated with the instinct a certain amount of associative memory by which they know landmarks and so keep the old path.

All past sensations leave impressions on the nervous mechanism. Nobody has ever been able to find any peculiar mechanical, molecular, or physical change in the cells of any nervous system which have been strained as compared with those which have not. There is, however, admittedly, some difference—probably a physical change of some sort, possibly analogous to the elastic set and afterstrain found in iron or steel or other materials, not recognizable by the microscope, but revealed by the character of the material itself; its molecular constitution has been modified.

Are these impressions stored in certain cells, or along the whole path of the influence? In perceiving light I see a peculiar form of light; the impulse travels through certain tracts—certain cells—of the brain; it has passed through a considerable path. Is this impression ultimately stored up in some cells which it has ultimately reached; or, is the impulse left along the whole path? It is very probable that it is not stored up in any one cell. We have such a limitless capacity for remembering the things of vision that our heads are never full; we do not begin to utilize the brains that we have; there is lying fallow an enormous amount of brain material which is never used; and yet, as a matter of fact, although the greater part of the brain is unoccupied and unused in the psychical processes, there is no doubt whatever that taking merely the things we remember having seen and then following out the optic tracts of the brain there are not enough cells for storing up all the visual memories. It must be, therefore, that we do not have a separate memory stored in every cell—that we have more memories than we have cells; that we need not expect a little corpuscle in every cell for a certain memory, but that there has been an impulse traveling along the nerve which has changed its whole character all the way along the path; and that when it is again traversed in the same way, or when some impulse from within starts, this same process will bring back the original sensations which we had stored and for a long time latent in this nerve path.

Associative memory is the fused impressions of processes which occur together, so that when one is again recalled the other comes with it; we cannot separate them; the two things are connected. When I speak the word "white" there comes to every person's mind a certain image that is united, indissolubly bound up, with that certain sound. I have a visual image stored in the brain associated with a certain auditory image expressed by the word "white;" and so on with all our words and with all the things, practically, with which we deal in ordinary life.

I have been trying to show that the elements of the psychic life are analyzable—that they can be reduced to component parts; and this is particularly true of consciousness, which is perhaps the most complex of all the psychical phenomena. Consciousness, according to Mach, is the outcome of the fact that certain constituents of memory are constantly present, or are more constantly present and reproduced than other constituents, first of all being visual images of our own bodies. We recognize these; we know our own bodies; we know the sound of our voice, this is a part of ourselves; we recognize it as we do the sound of another's voice; and these two things together give us a certain consciousness of our body—a thing which is continually present with us. Then we have consciousness, too, or certain permanent complexes of memory—certain memories that have left their impress and that whenever the proper impulse comes will start and bring up again these same memories which are of a peculiar sort. These lend a certain permanence to the *ego*.

In the phenomena of the loss of consciousness, as in sleep or in fainting, we are dealing with the loss of associative memory. A German physiologist was studying the effects of the lack of oxygen, and when he reduced the oxygen in the room to a certain pressure he could no longer count—he began to lose memory. When he had figures written out before him he would go over them and try to connect the figure with the name for the figure; but when he found that he was beginning to miss—that he could not call the name of the figure before him—he knew he was about to faint. That came before the fainting—before the complete loss of consciousness; but he has shown this one thing; that what was first disturbed before complete loss of consciousness was observation—memory; he could not associate that visual sensation of the figure 4 with the auditory sensation of the word "four"—could not bring the two together; and when he found that he had gotten to that place in his experiments (since he was not attempting primarily to study the phenomena of consciousness), he cut off his experiments, but he knew that it was time to stop when he began to lose his power of associative memory. Associative memory, then, is the thing destroyed or lost in sleep; and it is by the loss of associative memory consciousness is lost, when one is struck on the head, or in fainting, or in any other phenomenon of the loss of consciousness.

In plants and the lowest animals there is no nervous system, no nerve cells, no nerve fibers, absolutely no nervous system; there are no sense organs in many of the lower animals and plants; and yet these same organisms respond to stimuli—almost all of these animals being sensitive to light, heat, electricity, to a great many kinds of chemical stimuli of various sorts. They are sensitive, but they have no sense organs. We are dealing, then, with a property which concerns not any particular organ, but the entire organism, that is, with that which is a fundamental property of living substance, which property we call irritability; or, we might call it sensibility—the power of receiving stimuli and being impressed thereby. This sensitiveness of these lower organisms we must suppose to be unconscious, if the view of consciousness such as I have put forward be correct; for they have no associative memory. It is easy enough to test animals as to the presence of associative memory. Any animal that can learn after any length of time to answer to its name, to answer to a certain call when it wants food, to connect together the thought of food (if it has such a thought, or at least the thought of its hunger and the appeasing thereof) with a certain call or a certain sign, has to that extent associative memory. It would be ridiculous to speak of the consciousness of plants and of animals such as these lowest ones having no nervous systems and no sense organs. This same is true of the sex cells, and they have, therefore, only this capacity of responding to stimuli—this irritability or sensibility.

A little higher in the animal scale, taking the group to which the jelly-fish belongs (the coelenterates), we find nerve cells scattered throughout the organism of the animal—at least, in most of them; but in some jelly-fishes we do have a little ring of nerve cells running around the edge of the umbrella, though it is a very loosely scattered nervous system; and here again there is no evidence of associative memory—of consciousness nor volition. There is one thing that would strike you at first as an evidence of volition; the sea-anemone has a cylindrical body, fastened to which at the upper end is a crown of tentacles; if you put a piece of meat on that crown of tentacles at once the tentacles begin to bend and carry it down to the mouth. If in place of bits of meat you put a piece of paper on the tentacles they will at once bend the other way and turn it out. If you tie a piece of meat to a piece of paper by a long string it will swallow the meat and throw the paper out and leave the string; connect the two closely together and it will swallow the two together and throw out the string. That it does not know how to choose food is shown by a very simple experiment. It was found that it was only a certain calcium salt in the meat that caused the tentacles to turn in, and so when you dip the paper in this calcium salt the animal takes in the paper for meat; there is no nutriment in it whatever for the animal, but that calcium salt stimulates the tentacles in such way that they contract, and contract so as to throw the food into the stomach. So in other lower animals phenomena which have been considered as choice—the hunting of food—turn out to be merely chemical reactions and in no sense whatever a searching for food or an evidence of choice. The fact that reflexes such as these I have described are often purposive, makes them look like intelligent acts.

Throughout nature among plants—the mosses between the bricks in the pavement—they all show purposive phenomena, and yet we cannot suppose that they are intelligent—that they are directing their own acts to a certain end. In worms, however (coming to still higher forms), there is a definite nervous system and more complex reflexes which, if they concern memory organs, are called instincts; but there are no indications of memory association or consciousness, and the same is true of all invertebrates save only a few of the arthropods and mollusks. In the ants, bees and wasps there is an advance in psychic powers; they have wonderfully complex instincts which are further complicated by being united with associative memory. There is no question whatever that a bee leaving its hive and flying for a half-mile, as they frequently do, finds its way back by asso-

* Abstract of a lecture delivered before the Society of Ethical Culture, Philadelphia, by Prof. E. G. Conklin, Biological Department, University of Pennsylvania.

ciative memory. If one will study a queen bee on its first (the nuptial) flight it is found that she goes from the hive in the most anxious manner; she will come out and rise to a certain distance and get the bearings of the place—get these things fixed in her mind; she doesn't fly far until she comes back again; then she keeps circulating around and going a short distance and coming back, going a little farther and coming back—all the way fixing things, associating these with her home. Any bee that can go off a certain distance and find its way back must travel by landmarks; it cannot travel by any scent of itself in the atmosphere—it is out of the question; it must travel by association, which must be associative memory; so that we find among bees (and the same is true among ants and wasps) a certain amount of associative memory, and that their very complex instincts are made still more complex by this fact. The same is true of cuttle-fish and squid and the higher mollusks; they have a certain amount of associative memory; but with the exception of these two groups of invertebrates there are probably no invertebrates which do have that first stage in the development of the psychic life, namely, associative memory.

Among vertebrates we have a nervous system varying from the extreme simplicity of an ascidian or the simple nervous system of amphioxus to the bewildering complexity of that of man, and we have a corresponding grade of psychic phenomena. There are vertebrates of less intelligence than these ants, bees, wasps and cephalopods to which I have referred; so that intelligence does not follow exactly in the lines of evolution. We need not suppose that the latest animal evolved is the most intelligent and that the earliest ones, or some of the early ones at least, are less intelligent; but we have intelligence developed along various lines in arthropods, in ants and bees, and then along the vertebrate line in various directions, that is, the fishes are very unintelligent, have extremely little, if any, associative memory; the same is true of frogs; among the birds we get a great deal of associative memory as in the mammals; but those fishes which stand in the relation of ancestor to the higher vertebrates, the amphibia, for example, are not necessarily the most intelligent. In short, intelligence seems to follow in the lines of a more and more complex nervous system.

(To be continued.)

TRADE SUGGESTIONS FROM UNITED STATES CONSULS.

Greek Currants for American Markets.—Considerable attention is just now centered about the formation of a stock company in this city, with the express object of developing the Greek currant trade with America, but more especially within America. It is probable that such a movement will be of more or less interest to American currant importers, and of especial importance to our own growers of this fruit, hence I take occasion to outline the nature and purpose of the company, so far as its formation has progressed at this date.

The impetus for the organization of such a company seems to have arisen in this way: A few days ago, one of the local dailies printed some editorials dealing with currants and the currant trade, and expressly with the further development of the trade with the United States, basing the articles principally upon the statements of a Greek merchant lately returned from New York. This merchant allowed himself many criticisms of the currants shipped by local exporters to the American market, characterizing the qualities for the most part as unfit for our trade and most unlikely to attract a larger consumption on the part of the American people. Not only were the qualities objectionable, he affirmed, but the manner of placing them upon the market was in no way calculated to reach the mass of the people, which Greek exporters feel that they must do if they are to increase the trade in their fruit. As a retailer, he said, he had every reason to know the quality of currants handed over to the smaller merchants for distribution, especially to the working classes; that these were not currants, but the rubbish of every sort incident to currant packing; and that the purchaser of such a grade of goods was never guilty of a second investment.

These and other statements, published with comments in regard to the prevalent fallacy that Greece grows all the currants for the world's markets, coupled with the fact that the Peloponnesus is likely to have more currants this year than she knows what to do with, according to present crop reports, have attracted considerable local attention. The first of a possible series of results is the formation of a company composed of four representative currant exporters and of the Currant Bank of Greece, with a capital stock of £3,000 ($14,600). Who is at the head of the company has not been given out, but it is probable that the Currant Bank itself is most active in its formation. The company proposes to open a distributing center, probably in New York, to put an experienced man in charge of the agency, and to supply Greek currants to the retail and small wholesale trade, to the exclusion of jobbers and large wholesale houses.

Knowing one of the stockholders whose name appeared in connection with the company, I inquired whether the company was actually to be formed, or merely to be talked of for the present. He assured me that the company was already in existence, and a recently-published interview with the director of the Currant Bank confirms this, so that there is little doubt that the company will be pushed into activity for the opening market in September. The principal difficulty seems to be in the selection of a suitable representative. There is no intention of putting a Greek or an American in charge, but an English expert is to be secured, if possible.

The fact that the United States consumed, for the year ended June 30, 1902, 18,200 tons of Greek currants, as against 70,500 tons by Great Britain for the same period, is unexplainable to exporters in general, because they will neither believe that America grows her own currants, nor that any market can be satisfied with any but Greek currants. At the same time, the very favorable outlook for a large crop this season is disconcerting, in view of the probable effect upon the market. It is the general belief that the yield will reach almost 175,000 tons; the Currant Bank will, therefore, press its law of retention to the highest point, which means to the growers, small or large, that probably the fifth of their crop will find its way into the storehouses of the bank at practically the cost for labor. In all probability, therefore, a great effort will be made to break into our market with larger quantities than hitherto.—Frank W. Jackson, Consul at Patras.

Railroad Construction in Indo China.—By Presidential decree promulgated on July 25, the government of Indo China is authorized to realize by means of a loan the sum of 70,000,000 francs ($13,510,000) for the purpose of constructing railroads in the French colony named. The loan is permitted under the terms of the law of December 25, 1898, which provided for a maximum issue of bonds to the amount of 200,000,000 francs ($38,600,000), to be sold under terms to be fixed by Presidential decree. The total amount is by the law mentioned restricted to the construction of the following lines: Haïphong to Hanoï and to Laokay, Hanoï to Nam-Dinh and to Vinh, Tourane to Hué and to Quang-Tri, Saigon to the Khanh-Hoa and to the Lang-Bian, and Mytho to Cantho.

Five days after the passage of the law, an initial loan of 50,000,000 francs ($9,650,000) was negotiated, and the issue of bonds to the amount of 70,000,000 francs ($13,510,000) is the second to be authorized. The money is desired to continue the construction of various of the above-mentioned lines, which has been actively pushed under the progressive administration of the distant colony.

The bonds have a face value of 500 francs ($96.50) each and bear 3 per cent interest, payable semi-annually, interest and principal guaranteed by obligatory inscription upon the annual colonial budget. In effect they are French government bonds, the budget being voted by the Chamber and Senate. These bonds will be taken up by lot annually after May 1, 1909, and will run in no case beyond seventy-five years. They are subject to no tax of any sort in Indo China, and in France are not subject to any revenue tax. Interest is payable in Paris. The bonds are offered for sale through all the important banks at 93—that is to say, at 465 francs ($89.75) for each bond of 500 francs ($96.50).

As the governor-general of Indo China has considerable latitude in the matter of conceding the exploitation as well as the construction of the railroad enterprises now in hand, this subject is not only important on its financial side, but suggests openings for American builders and furnishers. Probably, the most speedy method of securing information would be by addressing the Minister for the Colonies at Paris.—Robert P. Skinner, Consul-General at Marseilles.

American Mining Interests in New Caledonia.—A New Caledonian paper—La France Australe—reports in a recent issue the formation of an American company with important mining interests on this island.

The mines of New Caledonia have for some time exported considerable quantities of nickel and chrome to the United States, and these exports are certain in the future to increase very largely.

It will be noted that the International Nickel Company, the new concern, is composed entirely of American capitalists, and that in connection with Le Nickel Company, of Paris, it will practically control the nickel production of the world. The properties of this company embrace much of the finest mining land in New Caledonia. The feeling on the island is cordial to all American enterprise, and should the Oceanic Line make its proposed change of route, stopping at Nouméa, one may expect to see this colony dealing almost completely with commercial houses in the United States. There will then be an excellent chance for firms upon the Pacific coast to do direct business with Nouméa, as merchants here realize that they can buy supplies much more advantageously in our country than in Australia or Europe, provided the transportation facilities mentioned are afforded.—George M. Colvocoresses, Commercial Agent at Nouméa.

Trade Openings in the Philippines.—The Bureau of Foreign Commerce has received a letter from D. W. Yancey, Lucena, Tayabas province, Philippine Islands, saying that some industries in that vicinity are not being developed, principally on account of a lack of market. There is an opportunity to gather a high grade of sponge, as well as rubber and gutta-percha. In the timber line there is some fine ebony and other hardwoods. Mr. Yancey asks for the names of firms in the United States who are willing to buy the sponge, rubber, and gutta-percha products from the local producers in the islands.

French Demand for Cider Apples.—Consul J. C. Covert reports from Lyons, August 4, 1902, that he is asked to obtain prices for cider apples per 1,000 kilogrammes (2,205 pounds), delivered at Brest, Nantes, or Havre, duty paid in France.

INDEX TO ADVANCE SHEETS OF CONSULAR REPORTS.

The Reports marked with an asterisk (*) will be published in the SCIENTIFIC AMERICAN SUPPLEMENT. Interested parties can obtain the other Reports by application to Bureau of Foreign Commerce, Department of State, Washington, D. C., and we suggest immediate application before the supply is exhausted.

TRADE NOTES AND RECIPES.

Baking Powder.—It is manifest that in choosing materials for a baking powder the first consideration should be that of wholesomeness. There is apparently no substance available for the purpose which is absolutely free from objection from a hygienic point of view, but a near approach to the ideal is found in the familiar mixture of sodium bicarbonate and potassium bitartrate. This mixture leaves a slight residue of alkaline tartrates in the bread.

A formula for this powder proposed by Crampton, of the United States Department of Agriculture, as the result of an investigation of the leading baking powders of the market, is:

Potassium bitartrate	2 parts.
Sodium bicarbonate	1 part.
Corn starch	1 part.

The addition of the starch serves the double purpose of a "filler" to increase the weight of the powder and as a preservative. A mixture of the chemicals alone does not keep well.

The stability of the preparation is increased by drying each ingredient separately by exposure to a gentle heat, mixing at once, and immediately placing in bottles or cans and excluding access of air and consequently of moisture.

This is not a cheap powder; but it is the best that can be made, as to healthfulness; there are others which, while cheaper, are strongly and, we are convinced, justly opposed by sanitarians.—Drug. Circ. and Chem. Gaz.

Cleaning and Polishing Marble.—Marble that has become dirty by ordinary use or exposure may be cleaned by a simple bath of soap and water.

If this does not remove stains which may have been made, a weak solution of oxalic acid should next be applied with a sponge or rag, washing quickly and thoroughly with water to minimize injury to the surface.

Rubbing well after this with chalk moistened with water will in a measure restore the luster. Another method of finishing is to apply a solution of white wax in turpentine (about 1 in 10), rubbing thoroughly with a piece of flannel or soft leather.

If the marble has been more than commonly exposed, so that its luster has been seriously impaired, it may be necessary to re-polish it in a more thorough manner. This may be accomplished by rubbing it first with sand, beginning with a moderately coarse-grained article and changing this twice for finer kinds, after which tripoli or pumice is used. The final polish is given by the so-called putty powder. A plate of iron is generally used in applying the coarse sand; with the fine sand a leaden plate is taken; and the pumice is employed in the form of a smooth-surfaced piece of convenient size. For the final polishing, coarse linen or bagging is used, wedged tightly into an iron planing tool. During all these applications, water is allowed to trickle over the face of the stone.

The putty powder referred to is binoxide of tin, obtained by treating metallic tin with nitric acid, when the metal is converted into hydrated metastannic acid, which when it is heated becomes anhydrous. It is in this condition that it is known as putty powder. In practice putty powder is mixed with alum, sulphur and other substances, the mixture used being dependent upon the nature of the stone to be polished.

According to Warwick, colored marble should not be treated with soap and water, but only with the solution of beeswax above mentioned.

Talcum Toilet Powder.—Talc, when to be used as a toilet powder, should be in a state of very fine division. Antiseptics are sometimes added in small proportion, but these are presumably of little or no value in the quantity allowable, and may prove irritating. For general use, at all events, the talcum alone is the best and the safest.

As a perfume, rose oil may be employed, but on account of its cost, rose geranium oil is probably more frequently used. A satisfactory proportion is ½ drachm of the oil to a pound of the powder.

In order that the perfume may be thoroughly disseminated throughout the powder, the oil should be triturated first with a small portion of it; this should then be further triturated with a larger portion, and, if the quantity operated on be large, the final mixing may be effected by sifting.

Many odors besides that of rose would, of course, be suitable for a toilet powder. Ylang-ylang would doubtless prove very attractive, but a powder perfumed with that odor would be somewhat expensive.

We append some formulas for other varieties of the powder:

Violet Talc.

Powdered talc	14 ounces
Powdered orris root	2 ounces
Extract of cassie	½ ounce
Extract of jasmine	¼ ounce

Rose Talc.

Powdered talc	5 pounds
Oil of rose	½ drachm
Extract of jasmine	4 ounces

Tea Rose Talc.

Powdered talc	5 pounds
Oil of rose	50 drops
Oil of wintergreen	4 drops
Extract of jasmine	2 ounces

—Drug. Circ. and Chem. Gaz.

Liquid Polish for Copper and Brass.—Dissolve oxalic acid 15.0 and water 250.0 and mix with infusorial earth, finely powdered, 35.0. Shake this liquid well before using.

Another mixture consists of:

Sulphuric acid	30.0
Powdered pumice stone, A 1	20.0
Water	200.0

—Journal der Goldschmiedekunst.

Brillantine.—I. Olive oil 4 parts, glycerin 3 parts, alcohol 3 parts; scent as desired. Shake before use. II. Castor oil 1 part, alcohol 2 parts, saffron to dye yellow. Scent as desired. III. Lard 7 parts, spermaceti 7 parts, almond oil 7 parts, white wax 1 part.—Seifensieder Zeitung, Augsburg.

SELECTED FORMULÆ.

Preservation of Grape Juice.—It should be noted that fruits are likely to be dusty and may be soiled in other ways by handling so they should be washed before use, and this should not be neglected if the juice alone is to be used.

The juice of grapes and similar fruits is obtained by expression in an ordinary screw press, and strained through felt. By heating, the albuminous matter is coagulated and may be skimmed off, and further clarification may be effected by filtering through paper; but such filtration must be done as rapidly as possible, using a number of filters and excluding the air as much as possible.

If the juice is to be preserved as such, it is heated in the bottles intended to contain it and the bottles are sealed while still hot. The heating is accomplished by immersing the quite full and uncorked bottle in water, gradually heating the water and keeping at a boiling temperature for some time.

A better method of proceeding, however, for the pharmacist who makes a fruit juice for his own use is to convert it at once into concentrated sirup. This is done by dissolving about 2 pounds of refined sugar in 1 pint of the expressed juice. The sugar will dissolve in nearly this proportion without the aid of heat, and a sirup made "cold" will have a finer flavor, but the use of a gentle heat in effecting the solution will improve the keeping quality of the sirup.

The concentrated sirups so made are diluted with plain sirup as wanted in the proportion of about one to three.

The juices found in the market are usually preserved by means of antiseptics; but so far none have been proposed for this purpose which can be considered entirely wholesome. Physiological experiments have shown that while bodies suited for this purpose may be apparently without bad effect at first, their repeated ingestion is likely to cause gastric disturbance.—Drug. Circ. and Chem. Gaz.

Bleaching Ivory.—The following methods for bleaching ivory have been published. As will be noticed, the first is the simplest in form:

I. Wash the ivory well with ammonia water, then with water, and finally apply solution of hydrogen peroxide.

II. Expose the ivory for three or four days to the action of sunlight, in a bath of turpentine oil.

III. Treat the ivory alternately with a solution of potassium permanganate (1 in 250) and oxalic acid (1 in 100), letting the ivory remain in each solution for a half hour; then rinse well with water, and repeat the process a number of times.

IV. Place the ivory in a hot mixture of undissolved lime, bran and water; remove after a short interval, place in dry sawdust, and with the latter rub thoroughly; then expose to the air.

It seems not unlikely that the ivory after treatment by any bleaching process will require repolishing. If so, and it is not deeply scratched, rub with a woolen cloth charged with a paste made from Armenian bole and oleic acid. Wash with castile soap, and, after drying, rub with chamois. A few wipes with an old silk handkerchief completes the gloss. If scratched, but not very deeply, smooth with a rouge cloth and proceed as above. If very deeply scratched it will be necessary to scrape with a very fine steel scraper (a sharp knife blade will answer) or broken glass, rub with rouge cloth until all scraper marks vanish, and finish as first directed. Curved or moulded parts should be first scrubbed with an old stiff tooth brush charged with the paste above mentioned, then with a soft brush charged with whiting and a little ammonia, and finally scrubbed with soap and water, and finished with chamois.—Drug. Circ. and Chem. Gaz.

Perfume Tablets.—

I.

Lavender oil	2	drachms
Bergamot oil	2	drachms
Clove oil	1	drachm
Rose geranium oil	½	drachm
Vanillin	8	grains
Sweet almond oil	1	drachm
Paraffin	4	ounces

Triturate the vanillin with the almond oil, melt the paraffin and when nearly cold add the mixture and the other oils, stirring until ready to set.

II.

Lignaloe oil	2	drachms
Heliotropin	½	drachm
Bergamot oil	½	drachm
Lemon oil	½	drachm
Sweet almond oil	1	drachm
Paraffin	4	ounces

III.

Ylang ylang oil	2	drachms
Clove oil	1	drachm
Sandalwood oil	½	drachm
Coumarin	20	grains
Sweet almond oil	1	drachm
Paraffin	4	ounces

—Druggists Circular and Chemical Gazette.

Floor Varnish.—Theoretically the making of varnish is simple enough, but practically it is attended with some difficulty and also with danger. The main solvent for varnishes made from copal and other similar resins is hot linseed oil, and in the boiling the oil is likely to take fire. The kettles are provided with covers to cut off the air supply in case of accident. It is manifest that the operation must be conducted in a place where failure to extinguish the burning oil would not endanger the premises. The oil solution is subsequently diluted with spirit of turpentine.

Where a hard varnish is required, copal is preferable.—Drug. Circ. and Chem. Gaz.

Heliotrope Water.—

Heliotropin	2	drachms
Rose oil	15	minims
Bergamot oil	½	drachm
Neroli oil	5	minims
Alcohol	10	ounces
Water	6	ounces

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Scientific American Supplement.

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